Collaborative Virtual Prototyping:

An Assessment for the Common Support Aircraft Initiative

Last modified on 5/24/96

17 April 97

POC: NAVIAR
MS. Elveta McKinney 602-6200 ext 3455
Arlington, VA

COLLABORATIVE VIRTUAL PROTOTYPING EXECUTIVE SUMMARY

For the last 50 years, the United States has relied for its security on a unique industrial base that has provided superior weapon systems for our warfighters. The sustainment of this unique industrial base has become unaffordable and the national strategy calls for a "unified national industrial base" to supply our future weapon systems. To maintain the force structure needed for our security, the traditional relationship between quantity and price must be modified and a means found to effect a dynamic change in the cost curves we have been on for the last 30 years. Collaborative Virtual Prototyping (CVP) offers the possibility to do this and enable the acquisition of complex weapon systems at significantly reduced cost.

The Naval Aviation Team is procuring less weaponry than in the past, yet that weaponry must continue to provide our technological edge while meeting new requirements within our affordability goals. The Naval Aviation Team under the leadership and encouragement of the Assistant Secretary of Navy (Research, Development & Acquisition) is exploring strategies that rely on dual use and commercial technologies to hold down cost and promote innovation. This study examines the potential of CVP to meet these needs for the acquisition of future systems.

The Naval Research Advisory Committee examined how the Department of the Navy (DoN) could train more efficiently, refine new weapon system requirements, and acquire new or modified systems in a less costly manner. In their November 1994 report on Modeling and Simulation, they recommended adopting a new Distributed Simulation Based Acquisition (DSBA) process that:

- Promotes end-to-end verification of requirements matched to design, manufacturing, and supportability;
- Facilitates cost and performance trades for the complete life cycle.

Further, the study concluded that DSBA if properly implemented:

- Would enable a "try before buy" in a virtual environment using distributed simulation;
- Would solve problems that are usually first evidenced only after hardware has been produced; and
- DoN should begin evolving this technology with existing acquisition projects stating that the technology has been demonstrated and more demonstrations are not needed.

This report provides the framework and background information needed for applying CVP to the new Common Support Aircraft (CSA) initiative that is commencing the study phase within the Naval Aviation Team. The CSA initiative will examine the feasibility of performing the missions now accomplished by the S-3, ES-3, E-2, and C-2 aircraft by a single "common" aircraft. This study examines the state of CVP technology, forecasts its maturation in the next three to five years, identifies its acceptance by the aircraft and electronics sectors of the industrial base, identifies new business processes that maximize the exploitation of CVP, and provides recommendations for implementing CVP for the acquisition of the CSA.

Collaborative Virtual Prototyping is the application of **distributed** modeling and simulation in an integrated environment to support trade-off analyses throughout the product life cycle. It enables all members of an integrated product and process team to continuously interact through electronic modeling and data exchange; increases the insight into life cycle concerns; permits earlier testing through virtual proving grounds; and accelerates physical production through process optimization using virtual factories. Distributed simulations with integrated product and process models will permit detailed knowledge to be obtained earlier in the conceptual and preliminary design phases where it can have the most influence on life cycle cost.

The report contains three major sections:

- Technology Assessment
- Business Process Reengineering Investigation
- Demonstrated Benefits

The study identifies commercial and government programs using CVP technologies; reports the results of industrial site visits; and lists CSA specific conclusions and recommendations.

An executive summary of the three major sections follows.

CVP TECHNOLOGY ASSESSMENT

The first of the three major sections of the report is the Technology Assessment section, which is divided into three subsections:

- CVP Taxonomy
- Standards
- CSA Specific Applications/Tools

A CVP Taxonomy was developed based on the Advanced Research Program Agency Simulation-Based Design (ARPA SBD) program's architecture. The taxonomy enabled the logical grouping of the diverse technology programs and applications and enabled a more refined evaluation of the maturity level. CVP technologies were evaluated for maturity and applicability to the CSA initiative. Standards and related initiatives were examined and found to be key and fundamental to the success of this technology. Many state-of-the-art and state-of-the-practice applications and tools were examined for applicability to the CSA initiative.

CVP Taxonomy

The underlying SBD program's architecture is based on an information systems model of services and infrastructure. This architecture was used as a taxonomy to provide for a logical grouping of the applications and tools evaluated and examined. The taxonomy is divided into two major categories: Services and Infrastructure. Services are those functions that interact with the user (designer, program manager, engineer, analyst, etc.) and are grouped by team integration, product interaction, applications, and product and process data models. Infrastructure provides functionality to the user but resides in the background and does not directly interact with the user. CVP infrastructure is divided into three layers:

- Computing and Computer Networks
- Object Management
- Information Sharing

Taxonomy Infrastructure Layers

Computing and computer networks are at the lowest infrastructure layer. This layer provides the physical connection among distributed team members and consists of computers, supercomputing facilities, display technology, networking, and security. It enjoys widespread commercial use, is considered mature, and continues to improve at phenomenal rates.

The object management layer resides on top of the computing and computer network layer and

ensures the service areas work together and provide easy access to the tools and data regardless of where they may be located on the computing network. This layer provides the logical connection between distributed team members. Object management technology consists of object oriented programming languages, object request brokers, object oriented database management systems, and distributed computing environments. This technology has recently found widespread commercial use, is rapidly maturing, and will be considered mature for use by the CSA initiative in less than three years.

The highest infrastructure layer is information sharing. This layer supports the service areas by determining where desired information is, retrieves it when requested, and lets appropriate team members know when certain information has been changed. It relieves the user from having to know the formats associated with database storage and retrieval and the complexities of locating and retrieving data. It makes extensive use of knowledge based applications and expert system technologies. These applications are still in the research and development phase and have not reached maturity as evidenced by the lack of commercial products. This technology should mature over the next five years, but may require longer time before it sees wide use.

Taxonomy Services Area

The services area of the taxonomy consists of Team Integration, Product Interaction, Applications, and Product and Process Data Models. Team integration tools are those applications that permit team members who are geographically distributed to interact effectively and timely. The technology consists of shared electronic notebooks, electronic white boards, multimedia, and graphical interface tools that allow the assembly of application programs into megaprograms. This technology is beginning to see widespread commercial use in business and should progress into widespread use for engineering applications.

Product Interaction tools permit the team members to interact directly with the product. Computer-aided design and manufacturing (CAD/CAM) applications, virtual reality, and synthetic environments are examples of this technology. Virtual reality technology was found to be the least developed, while CAD/CAM was the most developed. Recent advances in CAD/CAM commercial packages including feature-based 3-D solid modeling with associativity; knowledge-based CAD; and the effective integration of CAD with CAM and analysis applications has dramatically improved their effectiveness and has significantly reduced product development times.

Application tools consist of warfare analysis models, engineering analysis models, and program administration tools (cost, risk, and scheduling applications). Noteworthy were the number of new commercial warfare analysis simulation tools being introduced. Although this service area will continue to develop, it is considered the most mature of all the service areas. The ability to integrate effectively the various application tools is key to the success of CVP technology.

The Product and Process Data Models service area provides the user with a comprehensive yet extensible model of the product and its associated processes. It provides access to product and process information over a disperse heterogeneous environment. This service area relies heavily on the STandard for the Exchange of Product data (STEP). This standard is evolving and recently was adopted by National Institute of Standards (NIST) as the preferred standard for technical data interchange over the Initial Graphics Exchange System (IGES) standard.

Standards

Standards are the foundation for open systems; they promote interoperability and portability. Within the Department of Defense, the Defense Information Systems Agency (DISA) serves as the focal point for information technology standards. DISA developed the Technical Architecture Framework for Information Management (TAFIM) to guide the development of architectures within DoD. Within the Department of the Navy, the Computer Resource Management study group proposed that a subset of the

TAFIM standards be adopted in the DoN Computer Resources Standards List (Circa 2000).

CSA Specific Applications

The CVP taxonomy is generic and must be tailored for each application. CSA specific services will be required for product interaction, applications, and for the development of product and process data models. Available contractor and Navy CAD/CAM and dome simulators satisfy most of the product interaction requirements. There is a wealth of CAD-based engineering analysis applications on the commercial market, and the DoD M&S community has developed many warfare analysis applications that CSA can leverage. Information on these applications is available in the form of catalogs managed by the DoD and DoN Modeling and Simulation Offices.

There are many programs within the DoD, Department of Energy (DoE), Department of Commerce (DoC), and National Aeronautics and Space Administration (NASA) developing applications that could be applied for CSA development. The programs developing applications that would be of most benefit to CSA are Joint Advanced Strike Technology (JAST), ARPA SBD, and SC-21. The CSA program should leverage these development activities.

BUSINESS PROCESS REENGINEERING

To implement CVP effectively, many cultural business changes need to be adopted by both government and industry. The Naval Aviation Team recognized this fact when it established its Competency Aligned Organization and created Integrated Program Teams (IPT) to foster innovation and reduce costs. One of the most innovative initiatives found within the TEAM was the creation of a distributed virtual enterprise by PMA-299. The enterprise known as the " All Digital Office" networks Chief of Naval Operations (CNO), NAVAIR/PEO, Navy Laboratories, and contractors to support the movement of information among participants. Other NAVAIR initiatives include:

- The Team Work Plan (TWP).
- The Acquisition Management System.
- CAD II andContinuous Acquisition and Life Cycle Support (CALS).
- AIM-9X Acquisition Reform and Modeling and Simulation Initiatives.

Many innovative initiatives were found within DoD. Most pertinent to the CSA initiative are the efforts within the Joint Advanced Strike Technology Program Office, which has introduced a number of initiatives to streamline acquisition and information among JAST enterprise members. They include extensive use of the Internet for passing information on all program activities, the use of the Internet for electronic acquisition and business transactions, and the use of Associate Contractor Agreements to ensure that information flows among contractors.

Within the aircraft and electronics sectors of the industrial base many new business practices are being implemented. A sample of these includes:

- The introduction of Lean Aircraft production principles.
- Exchanging 3-D solid models with suppliers.
- Exchanging production and procurement information with suppliers to create
- Just-In-Time inventories.
- Using electronic commerce to speed procurements.
- Commercializing military product lines.

Barriers to implementing CVP that have been identified include:

- DoD specifications and standards (now removed).
- Proprietary concerns about security and database integrity.
- Incomplete information technology standards.
- Maturity of some applications, tools, and services.
- Capital investment cost to small to medium size companies.
- The rate of change of technology.

DEMONSTRATED BENEFITS

An important element of the study was to identify the potential benefits of using CVP technologies. Benefits were identified using existing programs where CVP tools have been applied in the aircraft and electronics sectors of the industrial base. The following is a summary of selected highlights.

JAST

Affordability is a primary theme of the JAST program. A focus of the FY94 effort was to identify technologies and life cycle cost savings resulting from those technologies. Each of the large aircraft primes examined affordability. As an example, Boeing concluded that the fly-away cost of the new JAST aircraft could be reduced by 29%. As a result of the initial study efforts, technology maturation areas were identified and life cycle cost (LCC) savings goals assigned to those areas. The largest LCC savings are possible in the recurring fly away costs for the airframe and avionics. Using new technologies, a LCC saving for the structure of 10-12% was identified, and a LCC saving of 10 to 12% for the avionics was identified.

Aircraft Industry

Within the aircraft industry many examples of benefits have been cited. McDonnell Douglas was able to reduce the cost of selected components of the F/A-18 E/F from 70 to 75% by using high-speed machining to reduce part count, assembly time, and tooling. McDonnell Douglas integrated their design and manufacturing tools into a CVP environment called Design, Manufacturing, and Producibility Simulation (DMAPS). Using DMAPS on the redesign of the tail of the T-45 they were able to reduce the redesign time by 70% and the production costs by 35%. Using Lean Aircraft production principles, Lockheed Martin was able to reduce the price of the F-16 by 8.4% while receiving smaller orders. Lockheed has made an offer to reduce the price of the F-16 another 15% if the aircraft is purchased commercially. By using CVP tools on the design and production of the Comanche, a price reduction of 20 to 30% was made possible. Pratt & Whitney has forecasted that new CVP technologies will permit a new military engine to be designed and produced in 3 years instead of the present 10-year development and production cycle.

NAVAIR Reported Results

NAVAIR conducted a study to examine the savings of using electronic mockups for the V-22. For a Class III mockup, 166,400 man-hours were saved, schedules were reduced, and first time fit rates were improved to 90%. The cost savings were estimated to be $21.7M.

CONCLUSIONS AND RECOMMENDATIONS

CVP technologies are rapidly maturing. A wealth of commercially developed tools are now available and should continue to grow. In the next three to five years, the communications network infrastructure for high-speed data transfer that provides the physical connectivity should be available from many providers. Software that provides the logical connectivity is being commercialized now and will continue to develop over this time period. The knowlege-based information sharing technology may still require additional development but should see limited commercialization over this time period. Ongoing CVP technology programs in Navy M&S, ARPA, and JAST should be highly leveraged now and focused to support the CSA initiative.

New technologies and business practices are the foundation of world class business organizations. The aerospace and electronics components of the industrial base are investing in CVP technologies and altering their business practices. NAVAIR should examine these practices and adjust to these changes as required. The adoption of CVP collaboration technologies should facilitate partnering with industry.

Specific recommendations for the CSA initiative include:

- Develop a strategic plan for adopting CVP technologies and associated business practices.
- Develop an investment strategy for collaboration, product interaction, and application tools.
- Task the NAVAIR S&T community to focus on affordability issues associated with CSA.
- Task the NAVAIR M&S Working Group to identify the best models and simulations applicable to CSA.
- Develop procedures for sharing models and simulations with industry.
- Invest in existing models and simulations to enable their use in a distributed computing environment.
- Invest in CSA unique engineering and warfare analysis tools.
- Identify with industry those open system specifications and standards NAVAIR will implement.
- Rapidly transition successful technology and business practices from JAST.
- Demonstrate CAD-2 compatible STEP compliant product data transfer applications.

End of Executive Summary

Continue to Background and Approach

Return to Table of Contents

Background and Approach

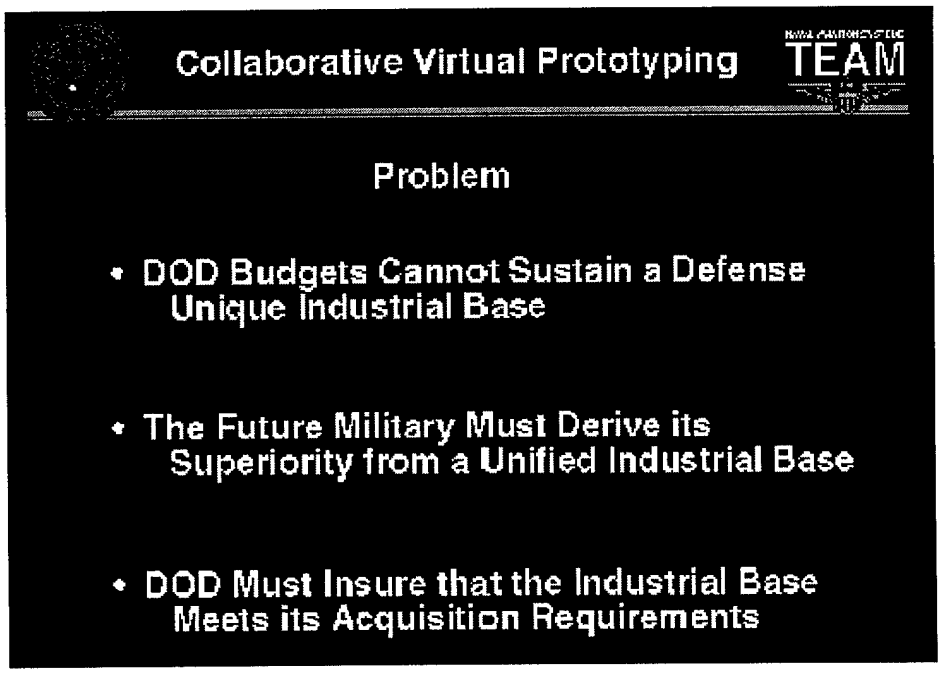
THE PROBLEM

For the last 50 years, the United States has relied for its security on a unique industrial base that has provided superior weapon systems for our warfighters. The sustainment of this unique industrial base has become unaffordable, and the national strategy calls for a "unified national industrial base" to supply our future weapon systems. Title 10 U.S.C. Chapter 148 states Congressional policy and objectives as:

1. Rely, to maximum extent practicable, upon the commercial national technology and industrial base to meet the national security needs.
2. Reduce the reliance of DoD on technology and industrial base sectors that are economically dependent on DoD business.
3. Reduce Federal Government barriers to the use of commercial products, processes, and standards.

To maintain the force structure needed for our security, the traditional relationship between quantity and price must be broken and a means found to drastically alter the cost curves we have been on for the last 30 years. Collaborative Virtual Prototyping (CVP) offers the possibility to do this and enable the acquisition of complex weapon systems at significantly reduced cost.

The Naval Aviation Team is procuring less weaponry than in the past, yet that weaponry must continue to provide our technological edge while meeting new requirements within our affordability goals. The Naval Aviation Team, under the leadership and encouragement of the Assistant Secretary of Navy (Research, Development & Acquisition) is exploring strategies that rely on dual use and commercial technologies to hold down cost and promote innovation. This study examines the potential of CVP to meet these needs for the acquisition of future systems.



INTEGRATED PRODUCT AND PROCESS DEVELOPMENT

TEAMS

CVP is the application of distributed modeling and simulation in an integrated environment to support trade-off analyses throughout the product life cycle. It enables all members of an integrated product and process team to interact continuously through electronic modeling and data exchange; increases the insight into life cycle concerns; permits earlier testing through virtual proving grounds; and accelerates physical production through process optimization using virtual factories. CVP brings the best and the brightest talent from across the unified national industrial base into integrated product and process development teams to concurrently engineer complex systems.

Advances in computer processing and networking have been the enabling technologies for CVP. Until recently, model and simulation fidelity was constrained by the amount of computer processing one could afford locally. Networking technology has removed that constraint, thereby allowing access to the best models and simulations wherever they may be located. This distributed simulation capability will permit detailed knowledge of the system to be obtained earlier in the conceptual and preliminary design phases where it can have the most influence on life cycle cost. These advances have allowed the formation of geographically distributed but electronically integrated product and process development teams.

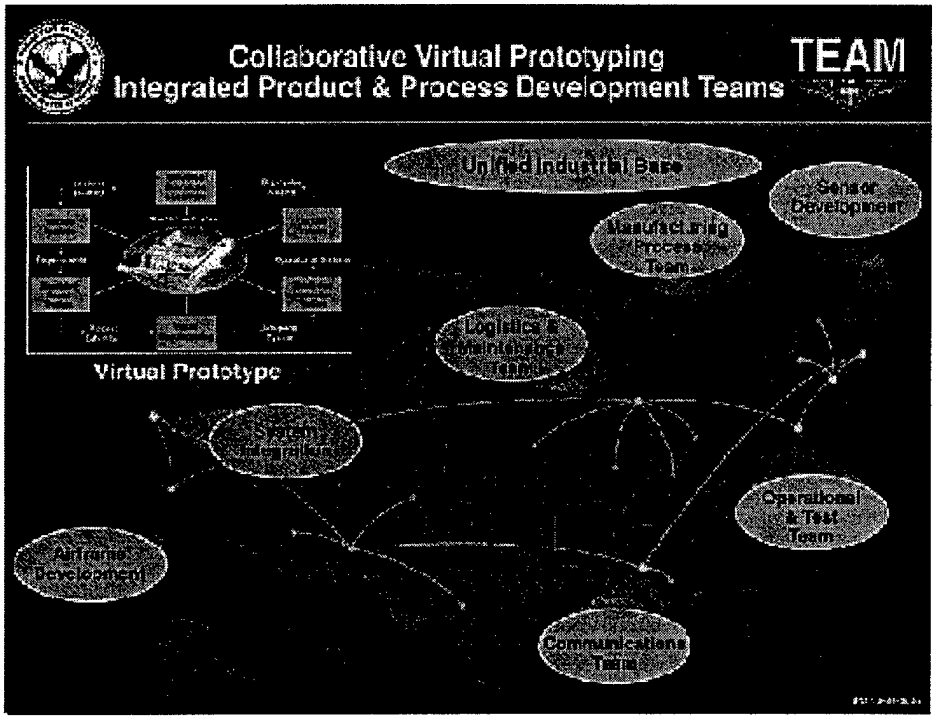
DoD leadership has fostered the development of this technology and its application to the acquisition process. DDR&E commissioned the Acquisition Task Force on Modeling and Simulation that reported out in June 1994, and the DoN tasked the Navy Research Advisory Council to examine the application of modeling and simulation within the Navy in an acquisition context.

The Naval Research Advisory Committee examined how the DoN could train more efficiently, refine new weapon system requirements, and acquire new or modified systems in a less costly manner. In their November 1994 report on Modeling and Simulation, they recommended adopting a new Distributed Simulation-Based Acquisition (DSBA) process that:

- Promotes end-to-end verification of requirements matched to design, manufacturing, and supportability;
- Facilitates cost and performance trades for the complete life cycle.

Further, the study concluded that DSBA if properly implemented:

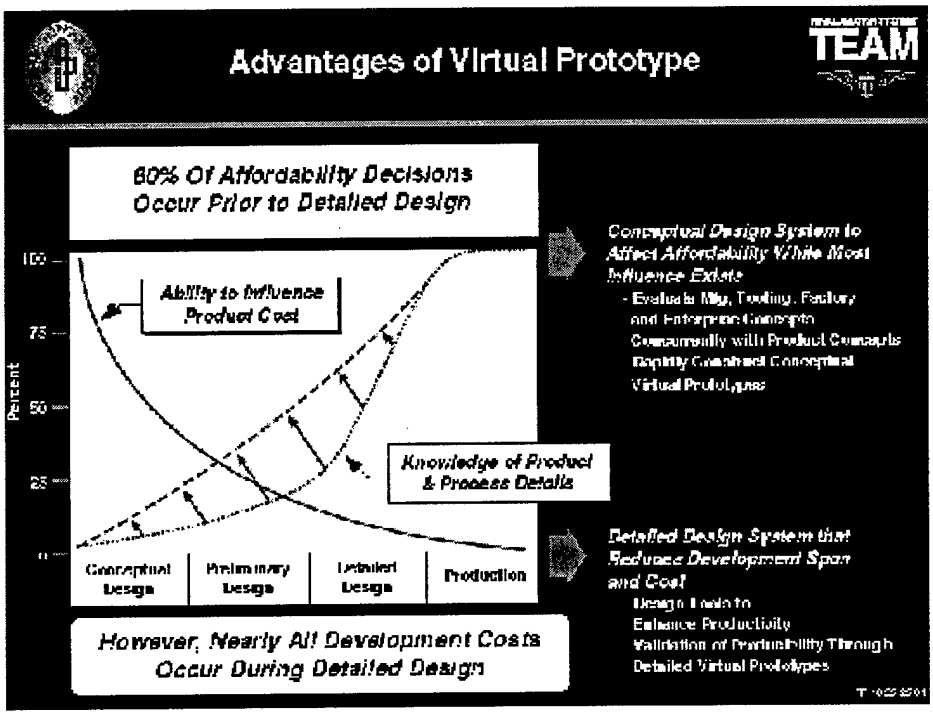
- Would enable a "try before buy" in a virtual environment using distributed simulation;
- Would solve problems that are usually first evidenced only after hardware has been produced; and
- DoN should begin evolving this technology with existing acquisition projects stating that the technology has been demonstrated and more demonstrations are not needed.



ADVANTAGES PROVIDED BY CVP

Eighty percent of development costs and seventy percent of the life cycle cost of a product are determined during conceptual design of that product. As the program moves from conceptual design into engineering and manufacturing development, the ability to change the design becomes more and more costly. The freedom to make design changes decreases as the knowledge about the design object increases. A progression from soft to hard information occurs from conceptual through detailed design.

The Systems Realization Laboratory at the Georgia Institute of Technology has studied virtual prototyping and has found that virtual prototyping "drags" the knowledge curve to the left and increases the ratio of hard to soft information that is available in the early stages of design. The improvement in the quality of information should lead to designs that are completed in less time and at less cost. Another important factor is to keep the ability to influence product cost or "design freedom" open as long as possible. This factor would be shown by moving the "ability to influence product cost" curve upward (not shown on this chart). The Systems Realization Laboratory hypothesizes that virtual prototyping enables both curves to shift. It is this shift that enables producers to change the cost curves they have been on for the last thirty years.

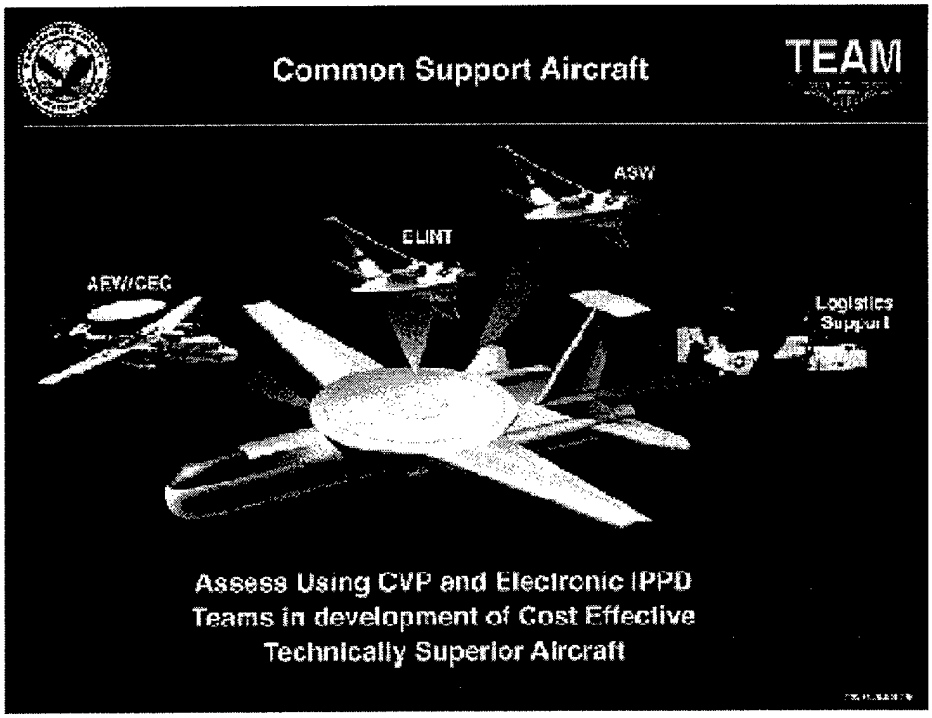


THE COMMON SUPPORT AIRCRAFT

Current carrier-based tactical mission support aircraft (S-3, E-2, ES-3, and C-2) will reach the end of their operational service lives between 2010 and 2015. For many airframes, mission obsolescence may occur sooner. A Naval Aviation Affordability Study, concluded in May 1993, determined that the more restrictive budgets require a "neckdown" in the types of airframes, reduced fly-away unit costs, and reduced life cycle costs.

The Chief of Naval Operations (CNO) plans to initiate a two-year study beginning in FY-96 to determine requirements and feasibility of using a common airframe to support many mission areas now performed by multiple platforms. The Common Support Aircraft (CSA) study will examine the possibility of combining the mission functions shown into a single airframe. The first year of the CSA study is devoted to collecting fleet inputs from the support aircraft communities and to performing unit and mission level analysis on those requirements. The second year is devoted to the development of a notional aircraft concept. The CNO study will develop a Mission Needs Statement (MNS) for the CSA. The MNS will outline the future carrier-based aircraft early warning (AEW), anti-submarine warfare (ASW), anti-surface warfare (ASuW), mine warfare (MIW), maritime and overland surveillance, C41, tactical intelligence, and tanking and logistics missions through the mid-21st century. The MNS will discuss the technical feasibility and economic benefits of a common airframe, and will determine the number of platforms of specific mission configurations to be procured.

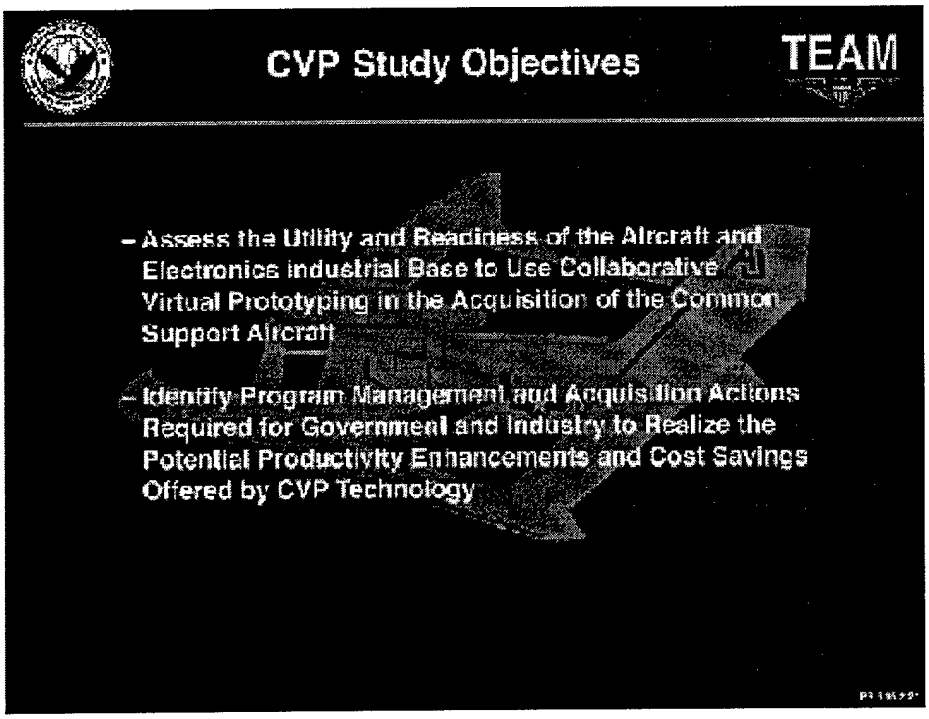
The results of the ongoing CVP study will feed into the CSA initiative. Future initiatives such as CSA should use those CVP technologies that are mature and offer significant cost advantages.



STUDY OBJECTIVES

This report provides the framework and background information needed for applying CVP to the CSA initiative. The study examines the state of CVP technology, forecasts its maturation in the next three to five years, identifies its acceptance by the aircraft and electronics sectors of the industrial base, identifies new business processes that maximize the exploitation of CVP, and provides recommendations for implementing CVP for the acquisition of the CSA. Specific objectives are:

- To assess the utility and readiness of the aircraft and electronics industrial base to use collaborative virtual prototyping technologies in the acquisition of the CSA.
- Identify program management and acquisition actions required for government and industry to realize the potential productivity enhancements and cost savings offered by CVP technology.



STUDY APPROACH

Three major sources of information were accessed to collect the information for the study:

- Government and Industry Development Activities
- Industrial Base Site Visits
- Conferences and Literature Searches

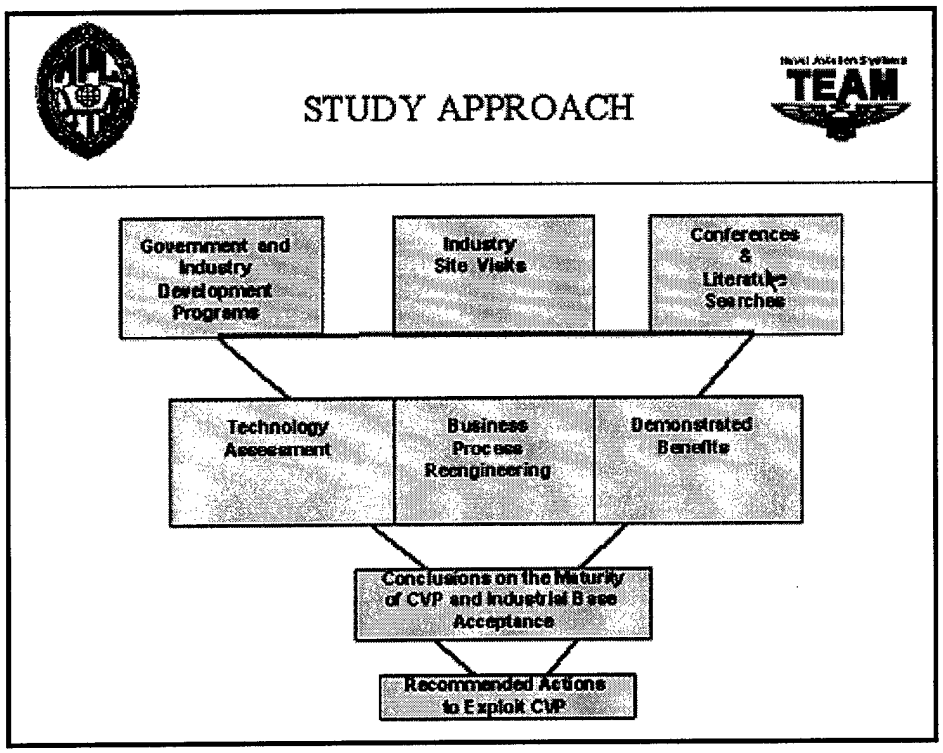
There are a number of government departments and agencies developing CVP tools and technologies. The Departments of Defense (DoD), Commerce (DoC), and Energy (DoE); the National Aeronautical and Space Administration (NASA); and the National Science Foundation (NSF) are all developing tools, integrating tools, developing advanced manufacturing processes, or are conducting pilot programs that can be used in the CVP environment. (Examples of these programs are provided on the next few slides.) Site visits were made to selected aerospace and electronics industrial base contractors and CVP tool developers. Literature searches, news articles, and conferences were also used as sources of information. Conferences that were attended by project personnel were AUTOFACT 94', the Defense Manufacturing Conference, and the National Institute for Standards and Technology (NIST) Advanced Manufacturing Conference.

The study was divided into three main areas:

- Technology Assessment
- Business Process Reengineering
- Demonstrated Benefits

CVP technology development is being sponsored by government and commercial organizations and is taking place largely in the academic community. The state of the art and the state of the practice were examined and enabling CVP technologies requiring additional development were identified. Many new business practices were identified during visits to large corporations and any demonstrated benefits were quantified and documented.

Information in the study areas was used to assess the maturity of CVP in both the commercial and defense components of the industrial base. In all cases, the aircraft and electronic sectors of the industrial base have either invested heavily in CVP or were developing programs to integrate their tools and departments into a CVP environment. Finally, there are a number of actions that NAVAIR and the DoN must take to exploit the benefits of CVP. These recommendations are presented at the end of the document.

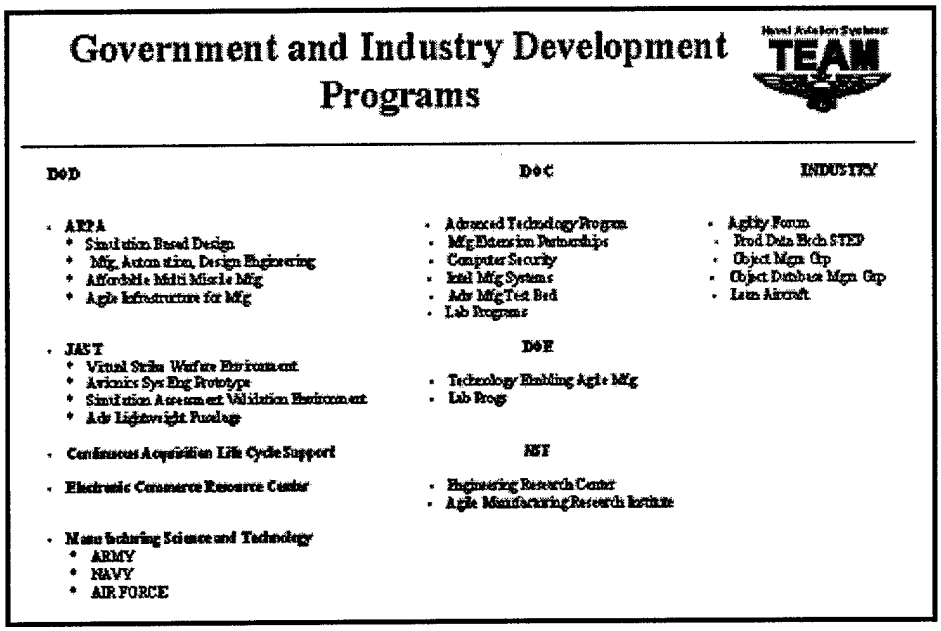


GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

There are numerous federal programs developing tools and technologies that can be leveraged when implementing collaborative virtual prototyping. The Advanced Research Projects Agency (ARPA) is leading DoD in developing technologies that support the distributing computing and collaborative design environment. The Simulation Based Design Program (SBD) is developing and demonstrating technologies to support the distributed, collaborative infrastructure. In addition, ARPA is sponsoring the Affordable Multi Missile Manufacturing (AM3); the Agile Infrastructure for Manufacturing (AIM); and the Manufacturing, Automation, Design, and Engineering (MADE) programs. The Joint Advanced Strike Technology (JAST) Program Office is maturing technologies that can be used for the next generation strike aircraft. Many of these technologies are directly applicable to the development and production of the CSA. Within the Manufacturing Science and Technology (MS&T) Programs of the Army, Navy, and Air Force are efforts in composites structures, high speed machining, and virtual manufacturing. The DoC has the Advanced Technology Program, the Manufacturing Extension Partnerships, the Partnership for the Next Generation of Vehicles, Intelligent Manufacturing Systems, Advanced Manufacturing Testbeds, and many NIST laboratory programs. The DoE is supporting an industrial consortium known as Technology Enabling Agile Manufacturing (TEAM), which is defining a common information infrastructure and conducting demonstrations of pilot projects. The NSF is sponsoring projects in Manufacturing Research including the Agile Aerospace Manufacturing Research Center located within the Automation & Robotics Research Institute (ARRI) at the University of Texas,

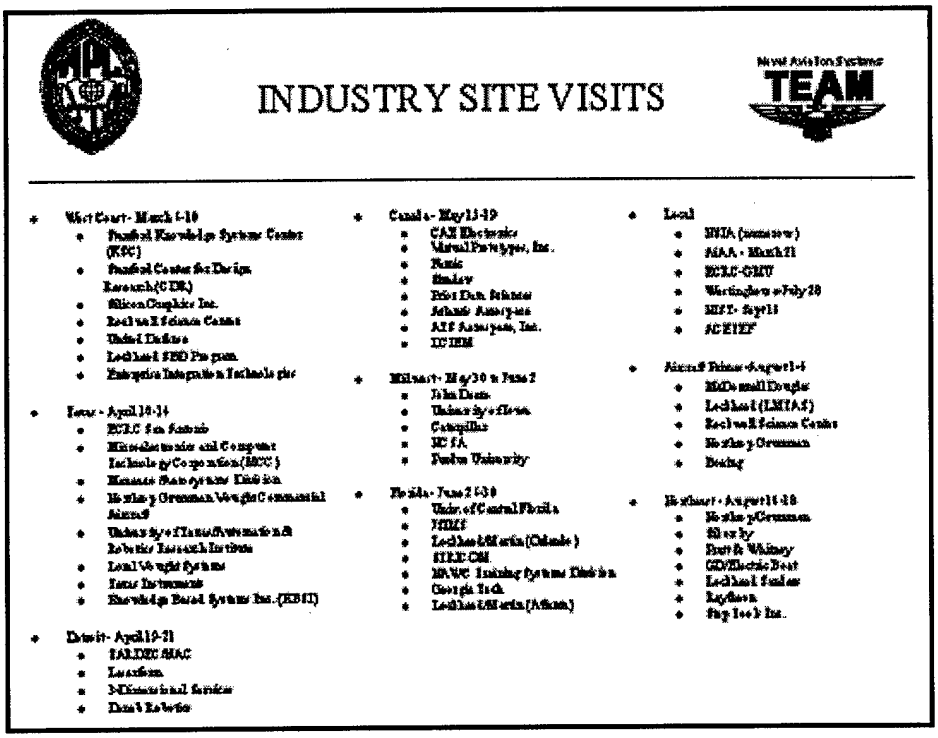
Arlington. It is one of three institutions to be designated an Agile Manufacturing Research Institute and is the only one dedicated to the Aerospace industry. Industrial consortia are focusing on the development of standards and manufacturing practices to help American industry compete in the world market. Standards are being developed by PDES Inc. and Object Management Group (OMG), while manufacturing practices are being identified by the Agility Forum, the Lean Aircraft Initiative (LAI), and Consortium for Advanced Manufacturing International (CAM-I).

Additional information on these programs is in Appendix C.



INDUSTRY SITE VISITS

Personnel from NAVAIR and the North American Technology Industrial Base Organization (NATIBO) collaborated in the collection of information for the CVP studies. From March 6 to September 14, 57 organizations were visited. The names of the organizations and the dates of the visits are presented in the accompanying slide. The information contained from those site visits is the foundation of this report, and the authors are indebted to the organizations that took their time to host the visit teams.



End of Background and Approach
Continue to Technology Assessment

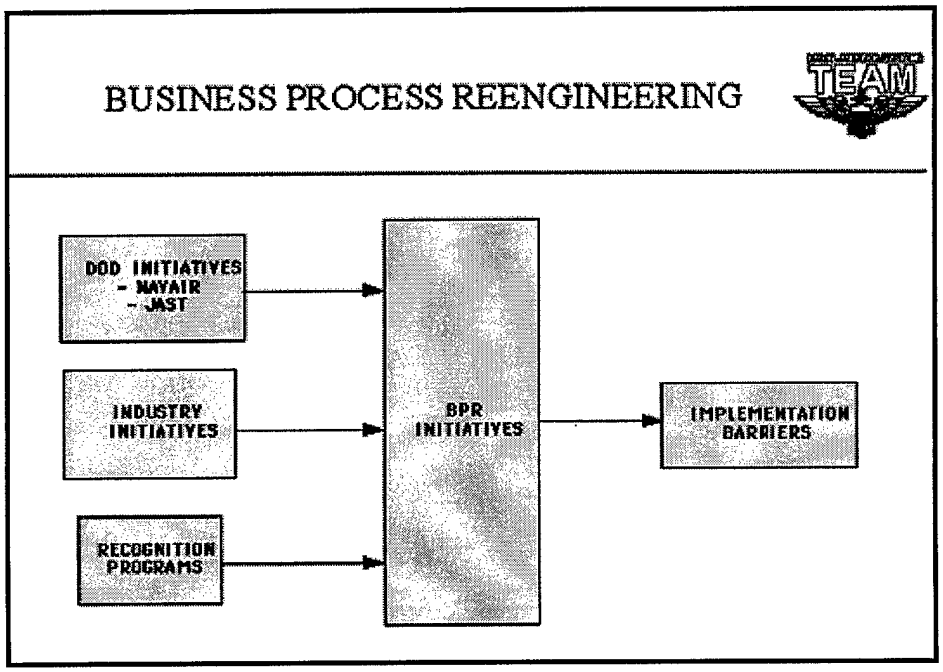
Return to Table of Contents

BUSINESS PROCESS REENGINEERING

To effectively implement CVP, many cultural business changes need to be adopted by government and industry. The objective of this component of the study is to identify potential business practices that will maximize the benefits of CVP. The current initiatives that have met with success, and the technical and business barriers in implementing CVP were identified. Information was collected from a variety of resources: a) current NAVAIR initiatives; b) new business practices within the JAST program; c) new business practices being explored in pilot projects within industry; and d) the recognization programs, i.e., quality and performance programs, sponsored by industry and government to overcome the current business practice barriers. Potential business processes that may be useful to NAVAIR and the CSA program in exploiting CVP were identified as a result of the above investigations.

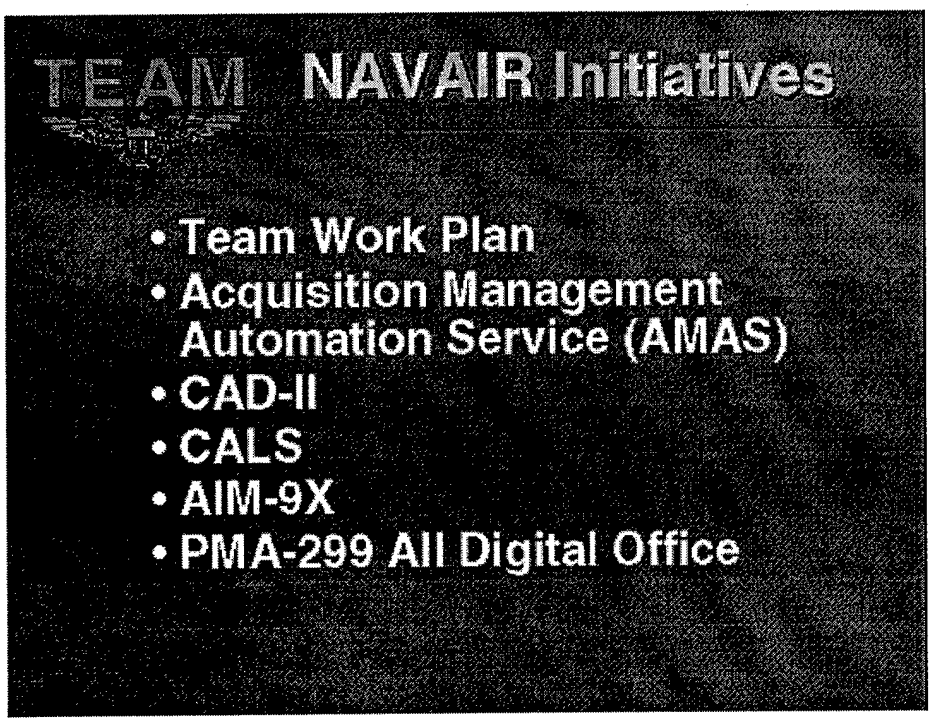
DOD INITIATIVES

Within the Department of Defense, two main areas were examined for their relevance to CVP: NAVAIR initiatives and new business practices within the JAST program. Technologies and work processes potentially valuable to CSA have been identified in the following slides.



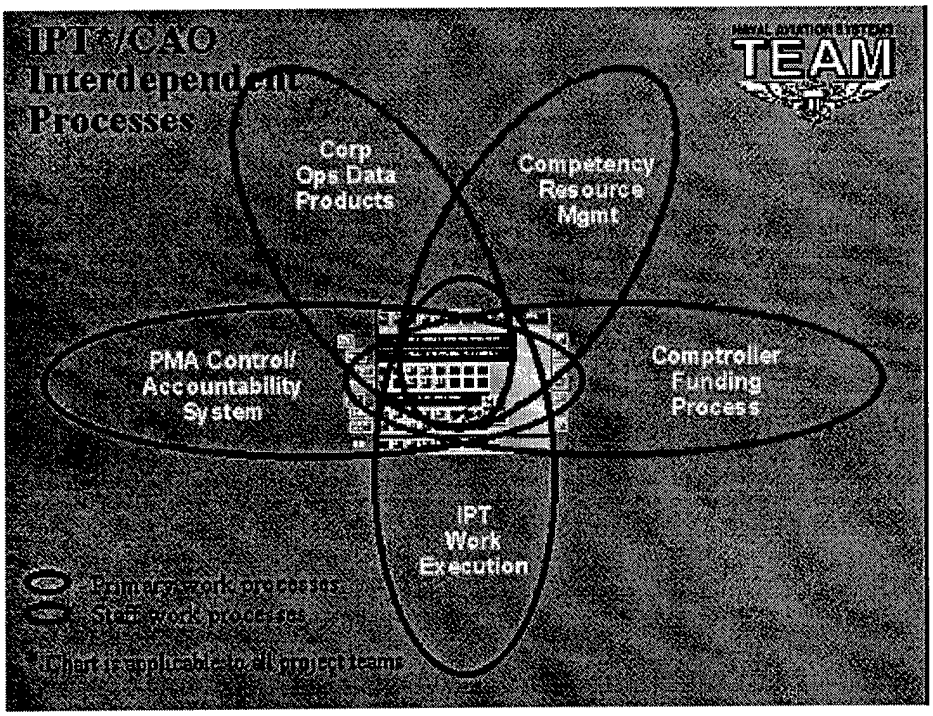
NAVAIR INITIATIVES

NAVAIR initiatives identified are the Team Work Plan, Acquisition Management System, CAD-II, CALS, AIM-9X, and the PMA-299 All Digital Office. These programs are heavily involved in CVP relevant issues such as interoperability; modeling and simulation during system design to reduce program costs; and the electronic Integrated Program Team (IPT) concept for acquisition. The approaches and the lessons learned by these programs can assist the CSA team in establishing its own CVP program.



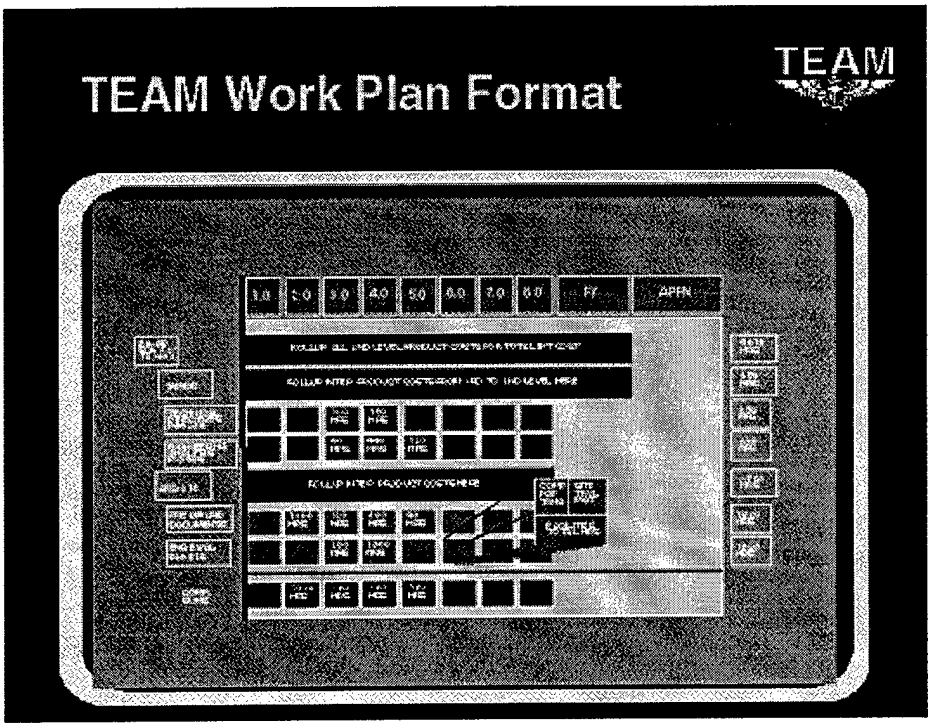
NAVAIR TEAM WORK PLAN

The Naval Air Systems Command has adopted a product-focused life cycle management philosophy that systematically employs integrated program teams, led by program managers, to manage all aspects of a program's product(s) over its entire life cycle. Program teams drew upon the newly established Competency Aligned Organization for human, fiscal, and other program-dedicated resources to accomplish their goals. The TEAM Work Plan (TWP) is the vehicle for defining and documenting requirements for work to be accomplished internally by the Naval Aviation Systems Team. It facilitates integrated, streamlined program management support from engineering, logistics, financial management, contracts, etc.



NAVAIR TEAM WORK PLAN

Initially, TWP will be implemented across the TEAM in FY-96 as a simple collaborative tool. It will use a RDBMS accessible over the NAVAIR network with appropriate access and security controls. The TWP collaborative tool will be the first enterprise-wide collaborative tool that changes an existing business process. Additional business-oriented collaboration functions such as desktop video, "electronic blackboard," sound clips, etc. should be rapidly added to improve usability, functionality, and overall efficiency.

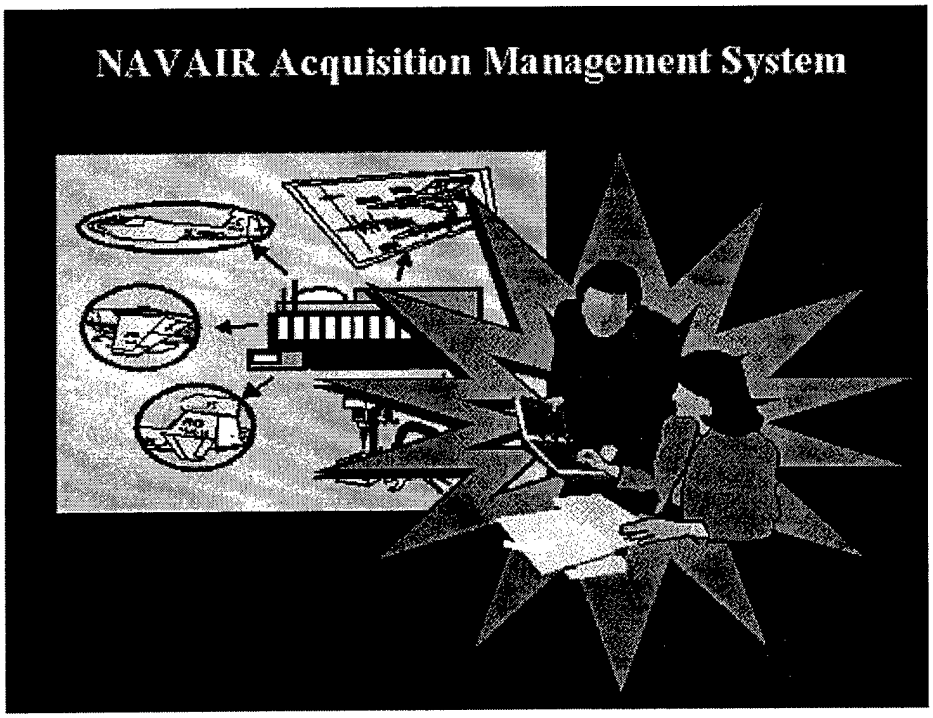


ACQUISITION MANAGEMENT AUTOMATION SYSTEM

The Acquisition Management Automation System (AMAS) is considered to be a mission-critical workgroup application that automates the acquisition process of creating, managing, and disseminating contract data for the organization. The AMAS is a system that comprises hardware and software applications designed to streamline the acquisition process across its complete life cycle and accommodate each phase of the acquisition process, from generation of the procurement request package to contract management and administration. As such, AMAS is a custom-designed software environment consisting of commercial software applications (MS Word, MS Excel, MS Project, and an electronic mail application) and a built-in-SQL environment, which will be used to automate the complete suite of contracting functions needed by its users. These contracting functions include workflow management and routing, reporting, operation, and administrative duties.

AMAS is divided into four application modules:

- Program Office Module
- Contracts Module
- Small Purchase Module
- Contract Management Module



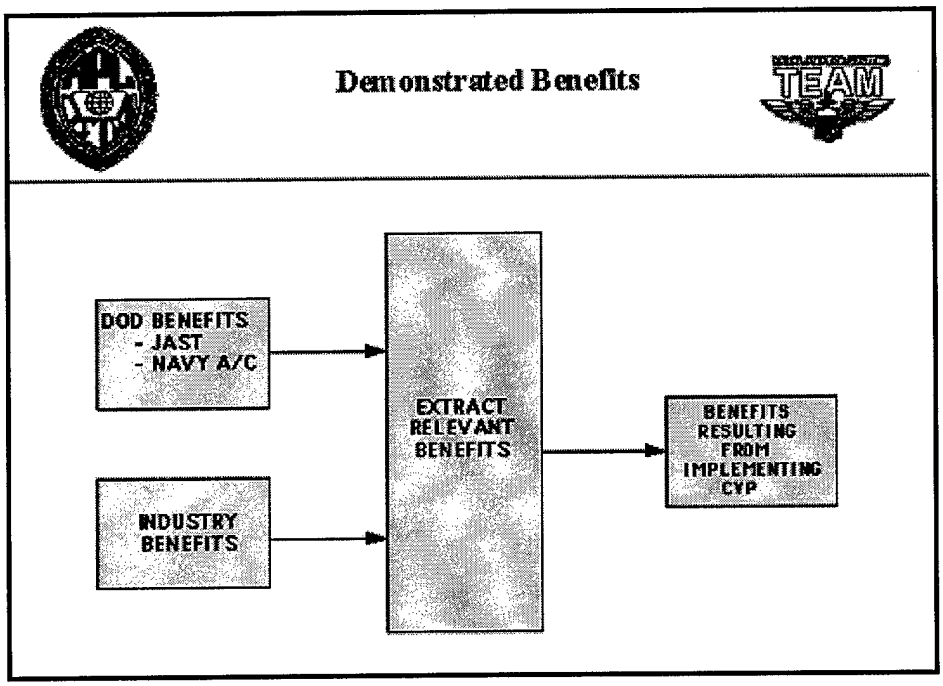
Continue with Business Process Reengineering - DoD Initiatives

Return to Table of Contents

Demonstrated Benefits

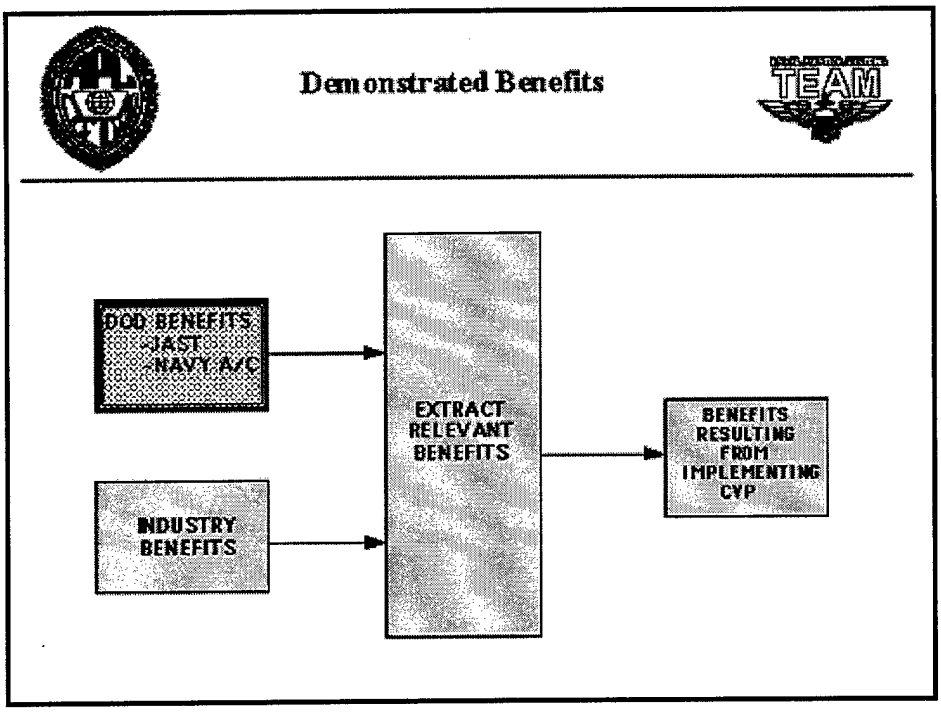
BENEFITS OF IMPLEMENTING CVP TECHNOLOGIES

Reforming or reengineering the acquisition process is a challenging and time-consuming effort. CVP technologies offer the potential for fundamental change within the acquisition community and the real prospects of major cost and time-to-market reductions. However, before major changes are implemented, management generally requires a cost benefit analysis to be performed. Performing such analysis for the Common Support Aircraft at this time is a difficult task since the CSA and its missions have not been defined. The approach used in this study is to identify the benefits that CVP technologies have had for other aircraft and DoD programs.



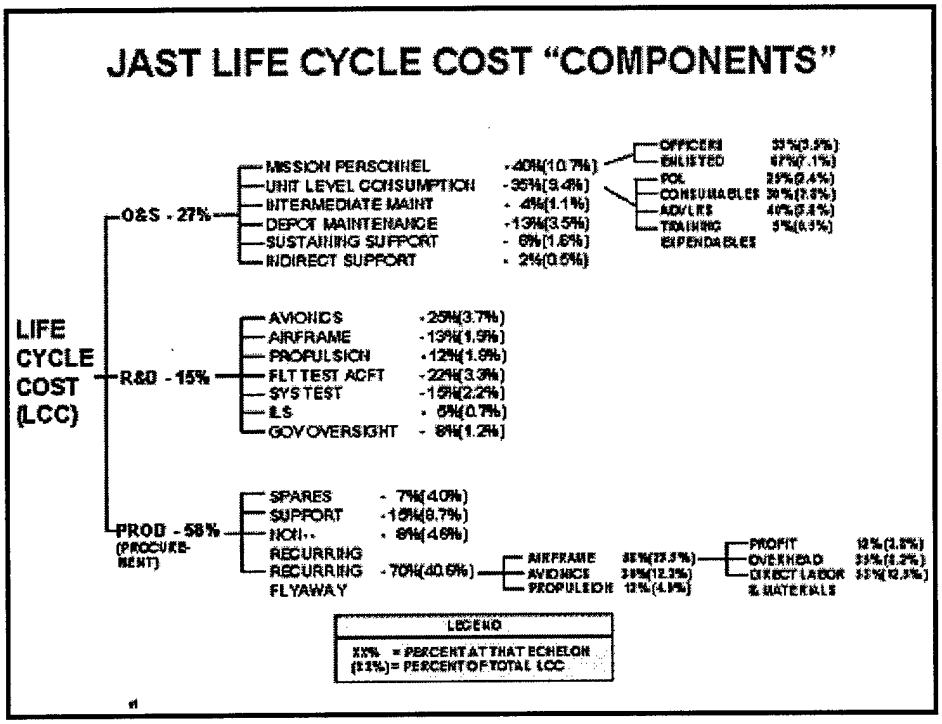
JAST AFFORDABILITY RESULTS

The largest aircraft program maturing technologies for affordability within the DoD is JAST. Life Cycle Cost reduction estimates and the technologies that support these reductions should be directly related to CSA. JAST material relevant to CSA is presented in this section.



JAST LIFE CYCLE COST COMPONENTS

The slide shows the estimated life cycle cost (LCC) breakdown of the JAST aircraft into the three life stages of research and development, production, and operation and service. The three major stages are further broken down into cost categories within those stages. Of the three major stages, production has the highest price tag of 58% of the total life cycle cost. Within production, the recurring flyaway cost accounted for 70% of the cost of production and 40.6% of the total LCC. The flyaway cost can be further broken down into the airframe, avionics, and propulsion. For the JAST aircraft, the airframe accounts for 23.5%, the avionics for 12.2.%, and propulsion for 12% of the total LCC. For the CSA, avionics is expected to dominate the recurring flyaway cost structure. This type of analysis is being used by the JAST office to determine where technology needs to be applied to reduce the cost of the JAST aircraft.



EXAMPLES OF JAST COST SAVINGS ESTIMATES

The following two slides present JAST projects and technology maturation efforts directed at reducing the major life cycle cost drivers.

The most significant cost driver for the CSA is avionics. Although the missions may be different between JAST and CSA aircraft, most of the avionics technology maturation deliverables can be employed to some extent by both aircraft. Architectures, virtual system engineering, virtual environments, and software development tools are directly applicable to CSA development. Using these technologies, JAST estimates an LCC savings of 9 to 17%. For CSA, the savings should be greater since avionics will have a higher percentage of the LCC.

AVIONICS ADVANCED TECHNOLOGY AREAS

AVIONICS ARCHITECTURE DEFINITION
- OPEN SYSTEMS ARCHITECTURE
- REDUCE COST OF AVIONICS UPGRADES
- CAPITALIZE ON JIAWG/F-22 INVESTMENT
- FULLY DEFINED INTERFACE STANDARDS
- INTEGRATED SENSORS

TECH INTEGRATION & PROTOTYPING
- COST/BENEFITS TRADEOFFS
- VIRTUAL SYSTEMS ENGRG PROCESS

TECHNOLOGY DEMOS
- ARCHITECTURE
- CRITICAL TECH COST SAVINGS PROGRAM

SOFTWARE
- COMMERCIAL BASED S/W DEVELOPMENT & SUPPORT ENVIRONMENT
- COMPONENT REUSE

PRODUCTS
- MODULAR ROMTS PRIORITIZED
- OPEN SYSTEMS
- VIRTUAL DEMOS TO ID MILITARY UTILITY
- SYSTEM STUDIES TO QUANTIFY COST EFFECTIVE TECHNOLOGY

LCC SAVINGS

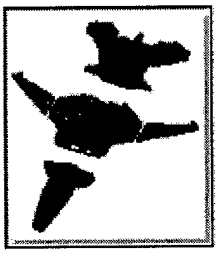
R&D	2 - 3%
PROD	6 - 14%
O&S	1 - 3%
TOTAL	9 - 17%

EXAMPLES OF JAST COST SAVINGS ESTIMATES

For the airframe, new materials and construction techniques help to reduce the life cycle cost from 10 to 12%. A large facilitator in new structures concepts and advanced production techniques is the use of virtual prototypes. These prototypes can be employed to perform structural analysis, producibility trade-offs, and for generating NC machine code. For the airframe, JAST has estimated that the new technologies could result in a LCC savings of 10 to 12%.

STRUCTURES & MATERIALS LEVERAGING TECHNOLOGY AREAS

MID FUSELAGE/WING
- UNITIZED CONSTRUCTION
- REDUCE PARTS COUNT
- REDUCE FASTENED ASSYS



AIRFRAME SENSOR INTEGRATION
- CONFORMAL, LOAD BEARING ANTENNAS
- DURABLE/AFFORDABLE EO/IR WINDOWS

AFT FUSELAGE
- HIGH TEMP MAT'LS & PROCESSESS
- DURABILITY
- PRODUCIBILITY

INLET DUCT/EDGES/ FRONT FRAME
- DURABILITY
- AIRFRAME INTEGRATION
- PRODUCIBILITY

AIRFRAME COMMONALITY
- OPTIMIZE AIRFRAME DESIGN FOR TRI-SERVICE AIRCRAFT
- AIRFRAME COMMONALITY FOR PRODUCTION COSTS & SUPPORTABILITY

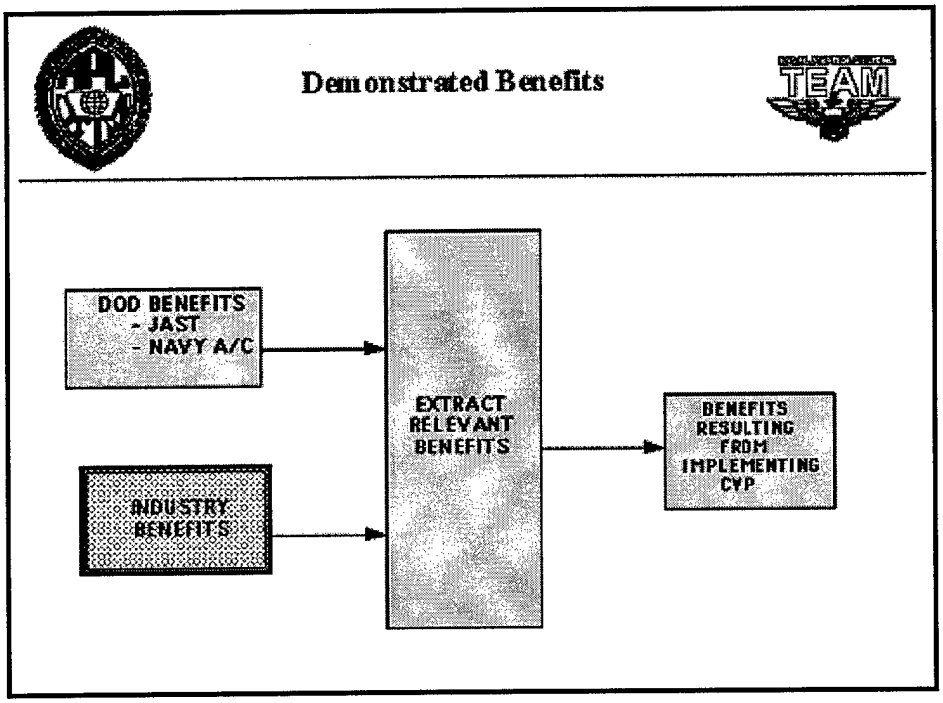
LCC SAVINGS

R & D	1 - 3 %
PROD	15 - 20 %
O & S	10 - 13%
TOTAL	10 - 12 %

INDUSTRY BENEFITS

One of the objectives of the industry site visits was to collect information on the benefits of CVP and related technologies that have already been implemented by industry. Obtaining this information was much more difficult than expected since identification of cost savings usually equates to lost jobs. In cases where staff reductions had already taken place, it was easier to disclose the savings. Some companies were very willing to discuss CVP benefits, whereas; others considered this information proprietary.

Many world class companies have already been implementing CVP technologies. New technologies have given them a competitive edge in the world market. The automobile industry is a leader in implementing virtual prototyping, exchanging 3-D solid model design data with their suppliers, and conducting electronic commerce. Two suppliers to the automobile industry (3-Dimension, Lazerform) and three CVP tool developers (Deneb Robotics, CADSI, Step Tools) were visited. Site visits were also made to John Deere and Caterpiller which are leaders in the heavy land moving equipment industry.



DEMONSTRATED BENEFITS

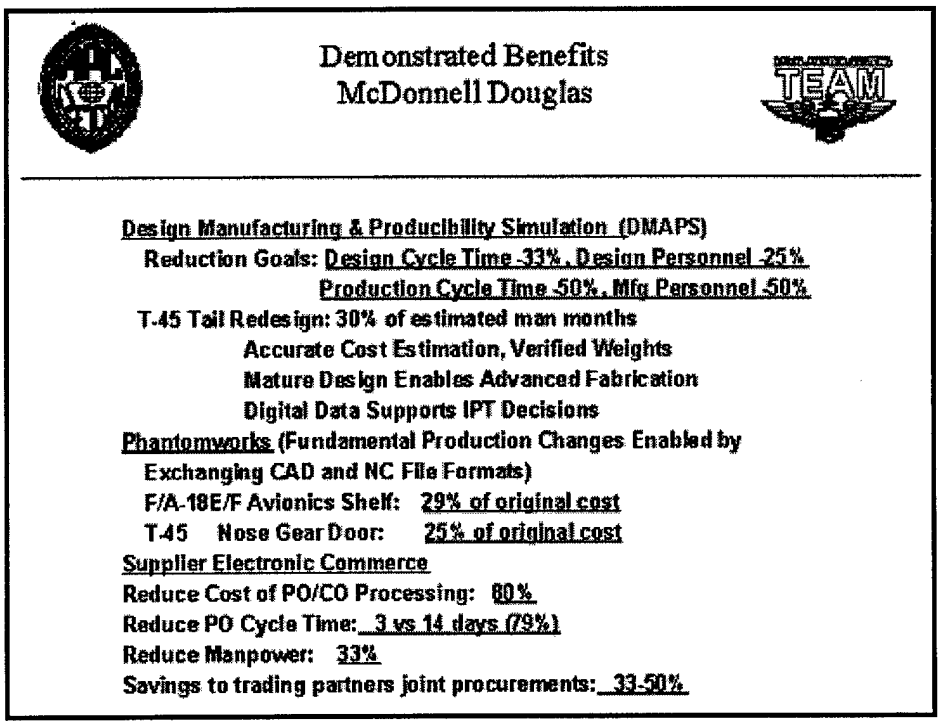
For FY 95, McDonnell Douglas is producing the majority of the fixed-wing aircraft for the DoD. Included in these procurements are the F/A-18, T-45, AV-8, C-17. McDonnell is also a JAST Weapon Systems Contractor teamed with Northrop Grumman and British Aerospace. The JAST program in conjunction with existing production gives McDonnell the opportunity to conduct pilot programs using current production assets.

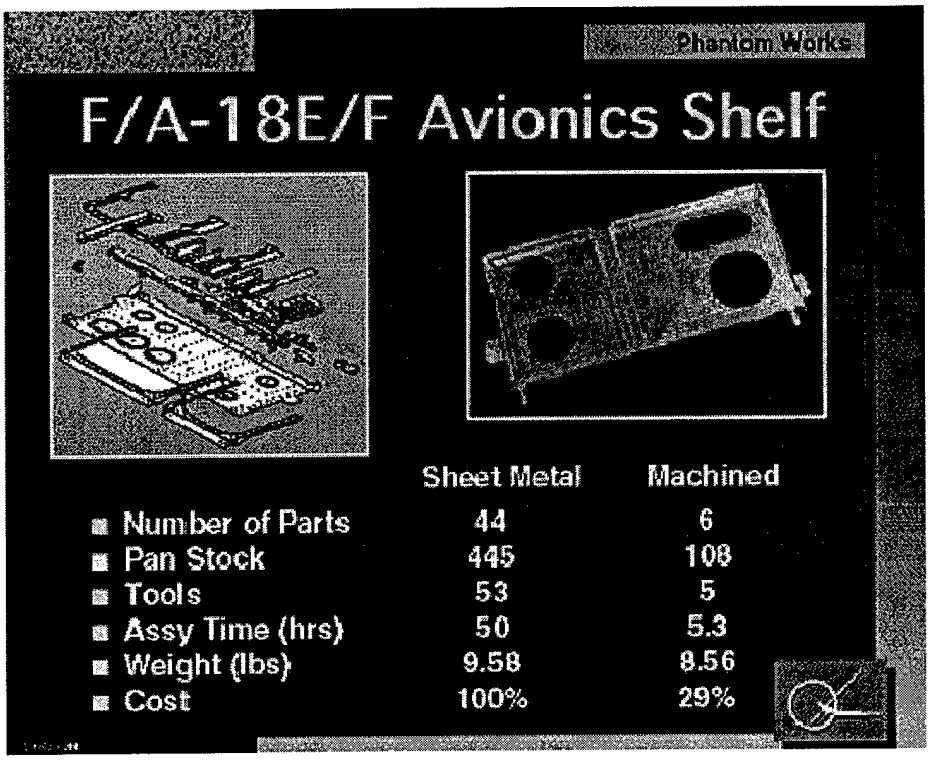
Design, Manufacturing, and Producibility Simulation (DMAPS) is a McDonnell program to tie together their product, process, and simulation (CVP-like) tools into a virtual prototyping environment. The objective of DMAPS is to reduce the acquisition costs by 50%. The integration of these tools will

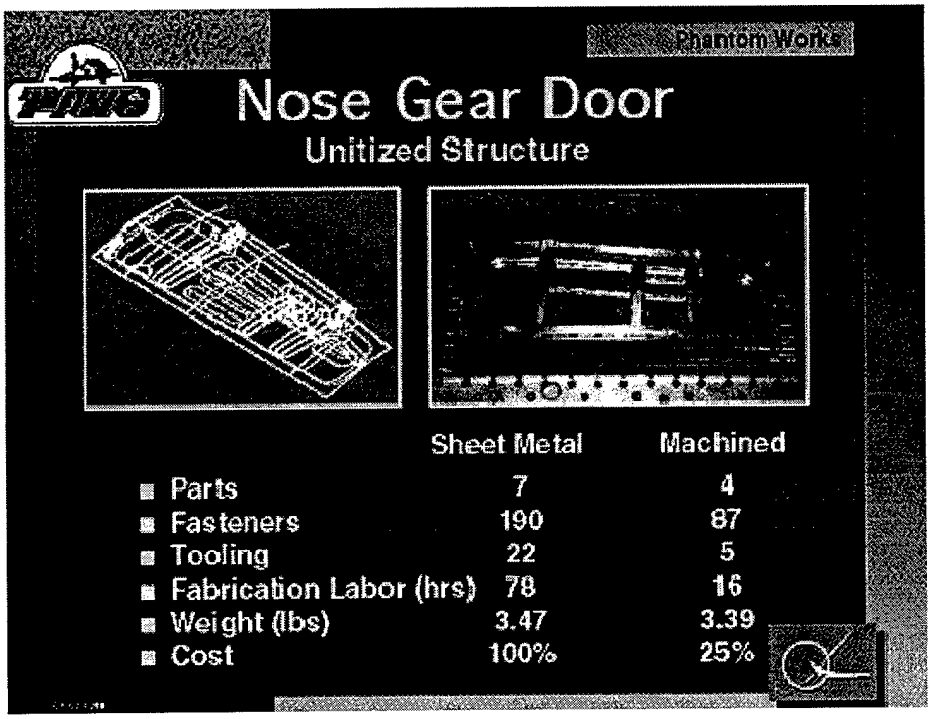
permit design time to be reduced by 33%, design personnel to be reduced by 25%, manufacturing cycle time to be reduced by 50%, and manufacturing personnel to be reduced by 50%. DMAPS was employed on the redesign of the tail for the T-45 trainer. The redesign was performed at 30% of the man-months previously estimated. The design included accurate cost estimates for production, verified loads and weights, 3-D solid feature based files for enabling advanced fabrication techniques (composite lay-ups, high-speed machining etc.), and an electronic visualization package for supporting IPT decisions.

Phantom Works is a McDonnell Douglas effort to change fundamentally the way aerospace systems are designed, developed, and produced. The center of this effort is electronic product data that can be employed in innovative fabrication techniques. These techniques include high-speed machining and composite lay-up to reduce the number of parts, tools, labor, assembly time, and cost. Examples of this are high- speed machining of the F/A-18 E/F avionics shelf and T-45 nose gear door. For the avionics shelf, the parts count was reduced from 44 to 6. Tools were reduced from 53 to 5. Assembly time was reduced from 50 to 5.3 hr, and the cost was reduced by 71%. Similar savings were experienced for the T-45 nose gear door where high-speed machining reduced the cost by 75%. The following slides give Phantom Works examples of pilot projects and achieved savings.

McDonnell Douglas has been achieving savings in supplier electronic commerce. This process makes them think differently about their suppliers. Using tools like a McDonnell-developed Buyer Workstation, they have been able to reduce the purchase order cycle time from 14 days to 3 days, manpower by 33% and the cost of processing purchase orders and contracts by 80%. These techniques are being employed for all orders over $25K and will be used for all orders in the near future. McDonnell has estimated savings through partnering of 33 to 50% on joint electronic procurements due to the larger volumes purchased.







Continue with Demonstrated Benefits

Return to Table of Contents

CONCLUSIONS & RECOMMENDATIONS

APPLICATION OF CVP TECHNOLOGY

There is intense interest within industry in collaborative virtual prototyping. Companies like Ford, Chrysler, Caterpillar, and Boeing have produced products using virtual prototypes in design and analysis and as replacements for physical mockups. There has been much publicity surrounding the development of the Boeing 777. Aircraft firms that previously were not using virtual prototyping now see this as mandatory if they are to remain competitive. The aircraft industry is employing many CVP tools for their applications. The following conclusions and recommendations are a result of visits and discussions with leaders in the computing, aircraft, and electronics sectors of the industrial base.

1. There exists a wealth of commercially available products and services to support immediate implementation of a CVP environment for the development of new products. The tools and infrastructure have been demonstrated in the JAST, MADEFAST, Boeing 777, Chrysler Neon, SBD programs.

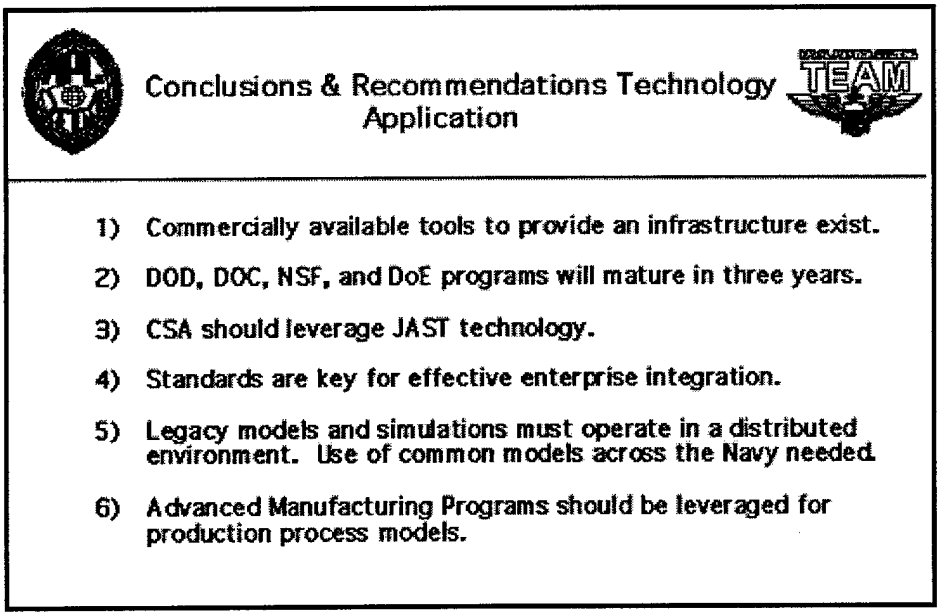
2. The DoD, DoC, NSF, and DoE are developing an infrastructure and a host of collaboration tools that should be available to new programs in the next three years.

3. There are aircraft specific applications and technologies being matured by the JAST program. These efforts should be leveraged for the development of the Common Support Aircraft.

4. Standards are the key element to all distributed enterprise activities. Without standards electronic media cannot effectively be exchanged among members of the enterprise. The DoN needs to select information exchange standards to be employed across all programs.

5. The majority of existing models and simulations needed to perform warfare analysis have not been developed to operate in a distributed computing environment. Effective use of these models requires in-depth knowledge of the assumptions and constraints of the models. Procedures must be developed to permit these models and their developers/operators to use these models in a distributed computing environment. Investments must be made to develop and maintain effective DoD Warfare Analysis models. Selection of common models to be used across DoN and DoD will reduce the investment cost and allow more capable models to be available to all users.

6. Producibility is a life cycle cost driver. Approximately 80% of the life cycle cost of a new product is determined during the conceptual design phase. Production process models for advanced manufacturing processes are needed for use in all phases of product development, but specifically conceptual design. There are numerous advanced manufacturing programs within the DoC, DoE, and NASA. The DoN should leverage these programs to provide the processing models needed for its programs.



APPLICATION OF NEW BUSINESS PROCESSES

1. The commercial sector is rapidly developing tools for distributed computing and virtual prototyping. World class companies are procuring these tools and developing additional application-specific products. These companies see these technologies as their competitive edge in the world marketplace. In cases where these technologies have been applied to new products, companies have seen significant reductions in time-to-market, improved quality, increased customer participation and satisfaction, and increased employee productivity.

2. Incorporation of the customer as a member of the IPPD team significantly reduces the development time since non-value-added activities can be minimized. Rapid trade-off decisions by the consumer helps to focus the teams activities.

3. New information and distributed computing technologies have spawned the formation of many small innovative companies. These companies not only offer products, but also provide a complete set of solutions and services to assist organizations in becoming proficient with new business processes.

4. ARPA Electronic Commerce Resource Centers are educating small to medium size firms in the use of electronic commerce. State-funded university programs are educating small to medium size firms on advanced manufacturing programs. NAVAIR should leverage these programs by working through primes to assist in modernizing critical suppliers.

5. NAVAIR should investigate the benefits of using commercial business practices in revolutionizing the acquisition process. Forming partnerships with industry as well as understanding and reacting to cost driving procurement actions can significantly reduce procurement costs.

Conclusions & Recommendations
Business Processes

1) The industrial base is rapidly adopting CVP technologies.
2) In cases where the customer has been a member of an IPPD team there hasbeen a significant decrease in the development time.
3) Innovative small companies are becoming more than just suppliers, offering products with information, services, and solutions.
4) Leverage ECRCs and state-funded university programs to modernize critical supplier organizations.
5) Promote commercial business practices and partnering with industry.

CSA RECOMMENDATIONS

1. **The Naval Aviation Team should:**

   Develop a strategy and plan for adopting CVP technologies (SBD) and associated business practices.
   Develop an investment strategy for collaboration, product interaction, and application tools. - Many multimedia collaborative tools will be available during the next 2-3 years for use by the Naval Aviation Team.

2. **The CSA initiative should leverage the newly established NAVAIR M&S Executive Committee to:**

   Survey existing models and simulations that will be applicable to the CSA initiative. The models and simulations should be categorized according to their functional discipline and the best selected for use within a distributed computing environment that enables rapid iterations and evaluation.

   Procedures and policy are needed that address the sharing and accessibility of appropriate models and simulations between government and industry. Electronic access to warfare models and simulations should facilitate the communication of mission and performance requirements while reducing cost.

3. **Developments within the S&T community should be focused to achieve an affordable CSA.**

   ARPA's Simulation Based Design program should demonstrate the viability of the required information technology infrastructure. A follow-on ATD should leverage the SBD infrastructure, continue development of the infrastructure as required, and develop/integrate the necessary tools or applications that are needed by the CSA initiative. Recommended applications include manufacturing process models and associated cost models.

   ARPA and ONR technology efforts should orient their testing/demonstrations to support the CSA initiative.

   S&T investments should be made in process technologies that reduce cost. Specific investments

are recommended to speed the development and approval of Application Protocols within the STandard for the Exchange of Product Model Data and a program that demonstrates interoperability of NAVAIR's CAD-2 system with various CAD packages using STEP.

S&T should invest in CSA unique engineering and warfare analysis tools.

4. **CVP technology should be used to facilitate the partnership between government and industry. Specifically:**

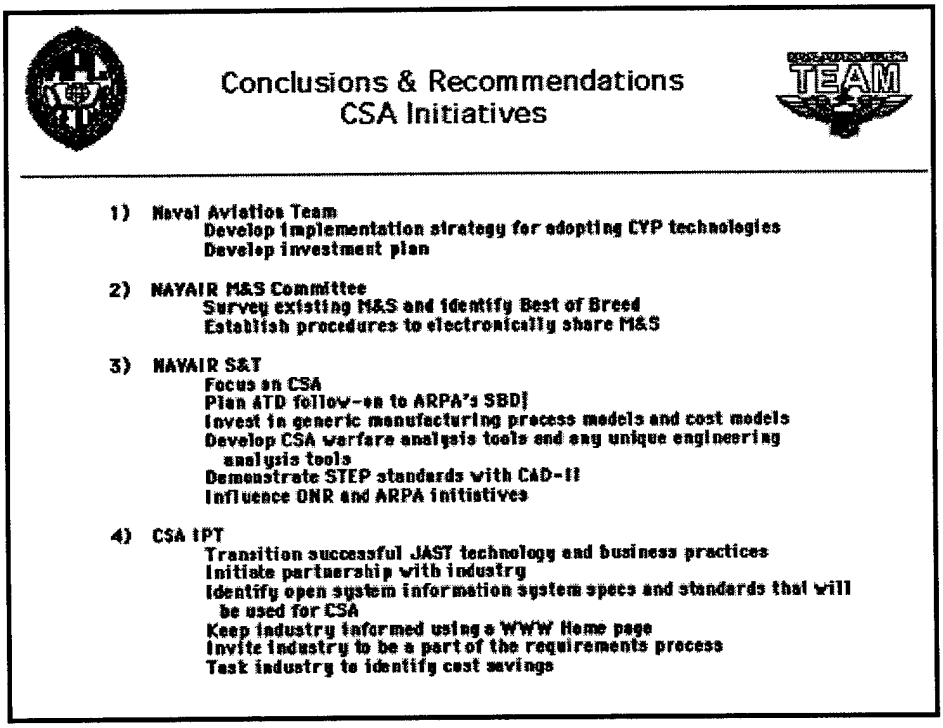
   The government should use DISA's "Technical Architecture For Information Management " (TAFIM) to identify those open systems specifications and the architectural framework that will be used for CSA.

   Emerging collaboration tools identified in this report should be used to support business and technical decision making. As a minimum, a WWW home page should be used to communicated the government's intent and to keep industry informed on the CSA.

   Industry should participate in the requirements development process to enable a more responsive and cost-effective design. The report identified many COTS software tools and applications that support the requirements definition and concept development phase.

   Industry should be tasked to identify cost reduction/avoidance initiatives applicable to the CSA. As a partner, industry can assist the CSA government team in identifying and understanding those initiatives that apply to the CSA. When combined with significant changes made by the government to its acquisition and business practices (ECI, IPTs, CIM, CALS, etc.), a highly streamlined acquisition approach may be appropriate for CSA.

5. **The CSA IPT should rapidly adopt and transition the successful technology and business practices from JAST.**

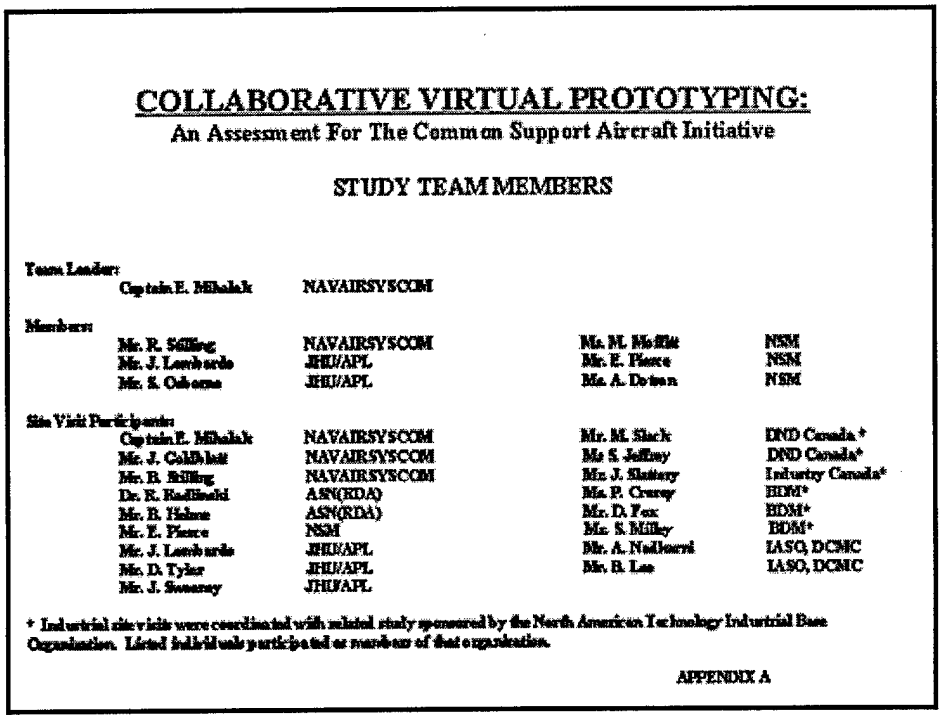


End of Conclusions and Recommendations

Return to Table of Contents

Appendix A

Collaborative Virtual Prototyping



COLLABORATIVE VIRTUAL PROTOTYPING:
An Assessment For The Common Support Aircraft Initiative

STUDY TEAM MEMBERS

Team Leader:

Captain E. Mihalik	NAVAIRSYSCOM

Members:

Mr. R. Stilling	NAVAIRSYSCOM	Ms. M. McHit	NSM
Mr. J. Lombardo	JHU/APL	Mr. E. Pierce	NSM
Mr. S. Osborne	JHU/APL	Ms. A. Dotson	NSM

Site Visit Participants:

Captain E. Mihalik	NAVAIRSYSCOM	Mr. M. Slack	DND Canada *
Mr. J. Goldblatt	NAVAIRSYSCOM	Ms S. Jeffrey	DND Canada*
Mr. B. Stilling	NAVAIRSYSCOM	Ms. J. Slattery	Industry Canada*
Dr. R. Radlinski	ASN(RDA)	Ms. P. Crespy	HDM*
Mr. B. Holmes	ASN(RDA)	Mr. D. Fox	HDM*
Mr. E. Pierce	NSM	Ms. S. Milley	HDM*
Mr. J. Lombardo	JHU/APL	Mr. A. Nadkarni	IASO, DCMC
Mr. D. Tyler	JHU/APL	Mr. B. Lee	IASO, DCMC
Mr. J. Sweeney	JHU/APL		

* Industrial site visits were coordinated with related study sponsored by the North American Technology Industrial Base Organization. Listed individuals participated as members of that organization.

APPENDIX A

Return to Table of Contents

Appendix B

Distribution List

3-Dimensional Services
Alan R. Peterson
Tan Industrial Park
2547 Product Drive
Rochester Hills, MI 48309
(810)852-1333

Advanced Research Projects Agency
Gary Jones
Tactical Tech Office
3701 North Fairfax Dr.
Arlington, VA 22203-1714
(703)696-2351

Agile Aero Manuf Research Center,
The University of Texas at Arlington
Dr. John J. Mills
7300 Jack Newell Blvd.
S. Fort Worth, TX 76118-7115
(817)794-5903

ASN (RDA) ARO
Mike Roberts
2211 South Clark Place
CP 5, Room 924
Arlington, VA 22244-5104
(703)602-5508

ASN(RDA/C4I)
Ben Helms
Room 5B731
1000 Navy Pentagon
Washington, D.C. 20350-1000
(703)602-8004

ATS Aerospace Inc.
Bill LaBerge
1250 Marie-Victoria
St. Bruno, QUEBEC, Canada J3V 6B8
(514)441-9000

BDM FEDERAL
Pamela E. Causey
1501 BDM Way McLean, VA 22102-3204
(703)848-6932
PCRAREY@LAN.MCL.BDM.COM

BOEING
Stan Schneider
P.O. Box 3707, MS 4C-49
Seattle, WA 98124-2207
(206)662-0141

Caterpillar Inc.
Robert A. Berdine
P.O. Box 1875
Peoria, IL 61656-1875
(309) 578-6528

Center for Manufacturing Tech
Richard E. Neal
P.O. Box 2009
Oak Ridge, TN 37831-8068
(615) 574-1862

Center for Naval Analysis
Dennis Shea
4401 Ford Avenue
Alexandria, VA 22302
(703) 824-2216

DENEB ROBOTICS
Robert Brown
3285 Lapeer Rd. West
P.O. Box 214687
Auburn Hills, MI 48321-4687
(810)377-6900

DMSO
LCOL Dave Bartlett
1901 N. Beauregard St.
Suite 504
Alexandria, VA 22311
(703)998-0660

DND
Michael Slack
National Def. Headqtrs.
101 Colonel By Drive
Ottawa, Canada K1A 0K2
(613)945-7106

Enterprise Integration Technologies
Dr. Jay Glicksman
800 El Camino Real
Menlo Park, CA 94025
(415) 617-8004

Fairfax Electronic Commerce Res. Center
H. Douglas Moser, Jr.
10540 Page Avenue
Suite 400
Fairfax, VA 22030-4000
(703)691-1507

George Mason Univ. Inv. of Public Policy
Dr. Ray Sommer
Fairfax Cals Shared Resource Center
10640 Page Ave
Suite 400
Fairfax, VA 22030-4000
(703)691-1507

Famic Technologies, Inc.
Frances Szeto
555, Dr-Frederik-Philips, Suite 300
Saint-Laurent, Qc, Canada H4M 2X4
(514)855-4914

CAE Electronics, Ltd.
Celine Gribbon
8585 Cote de Liesse
C.P. 1800
Saint-Laurent Quebec, Canada H4L 4X4
(514)341-6780

Atlantis
Phil D'Eon
1 Kenview Blvd.
Brampton, Ontario, Canada LGT 3E6
(905)792-1981

Industry Canada
Mr. Jamie Slattery
235 Queen Street,
RM 612A
Ottawa, Ontario K1A 0H5

General Dynamics Electric Boat
Gregory L. Angelini
D450, MS C62-45
75 Eastern Point Road
Groton,CT 06340-4989
(203)433-5227

Georgia Inst. of Technology
Dr. Pamokh Mistree
The Systems Realization Lab
George Wodruff School of Mechanical Engineering
Atlanta, GA 30332-0405
(404)894-8412

Georgia Tech Research Institute
Terry N. Hildebrand
Information Technology and Telecommunications Laboratory
Computer Science and Information Technology Division
Atlanta, GA 30332-3523
(404)894-3523

Georgia Institute of Technology
Dr. Edward W. Kamen
Manufacture Research Center
813 First Drive, N.W.
Atlanta, GA 30332-0560
(404)894-3564

IASO
Code: DCMDN-H
2800 South 20th Street
Philadelphia, PA 19145
Jim Nealon
(215)737-7597
(215)737-5360

JAST
Simeon H. Austin
Crystal Square 4, Suite 307
1745 Jefferson Davis Hwy.
Arlington, VA 22202
(703)602-7390 x6604
AUSTINSH@NTRPRS JAST.MIL

JHU/APL
Joseph S. Lombardo
Johns Hopkins Rd
Laurel, MD 20723-6099
(301)953-6287
JOSEPH.LOMBARDO@JHUAPL.EDU

Knowledge Based Systems, Inc.
Dr. Richard Mayer
One KBSI Place
1408 University Drive
East College Station, TX 77840-2335
(409)260-5274

LASERFORM, Inc.
Al Dewitt
1124 Centre Road
Auburn Hills, MI 48326
(810)373-4400

LMI
Edmund Muenkel
Logistics Management Inst.
2000 Corporate Ridge
McLean, VA 22102-7805
(703)917-7383

Lockheed Martin
Ronald Martin
P.O. Box 555837 MP-306
Orlando, Fl 32855-5837
(407)356-4728

LOCKHEED
Pamela K. Willey
Aeronautical Systems Company
Marietta, GA 30063-0674
(404)494-2700
PWILLEY@LASC.LOCKHEED.COM

LOCKHEED Ft Worth
Ross Meyer
Tactical Air Systems LMTS
P.O. Box 748, Mail Zone 1710
Ft Worth TX 76101
(817)777-0206

LOCKHEED Palo Alto
Mike Davis
0/94-01.B/251 Lockheed Missile & Space Co.
3251 Hanover St
Palo Alto, CA 94304-1191
(415)424-2135
davis@PC-SMTP.sdd.lmsc.lockheed.com

Lockheed Sanders
Bob Bassett
P.O. Box 868
Nashua, NH 03061-0868

LORAL
Cheval Force
9500 Godwin Dr.
Manassas, VA 22110
(703)367-6609
CHEVAL@LFS.LORAL.COM

Loral Vought Systems
Dr. B H. Bunzlaff
P.O. Box 650003 MS PT-91
Dallas, TX 75265-0003
(214)603-7986

MANUFACTURING TECH. USAF
Dilip Punatar
WL/MTAP
Wright-Patterson AFB, OH, 45433-6533
(513)255-3920 x250

McDonnell Douglas Corp.
Robert E. Bott
Mailcode 0010189
1735 Jefferson Davis Hwy
Arlington, VA 22202
(703)412-4051

MENASCO
Robert C. Grill
4000 South Hwy 157
Euless, TX 76040-7012
(817)283-4471

Microelectronics & Computer Tech. Corp.
Lyle L. Welty
3500 West Balcones Center Drive
Austin, TX 78759-5398
(512)338-3426

National Automotive Center
Mr. Jamie Flores
AMSTA-TR-NAC
Warren, MI 48397-5000
(810)574-6150

National Center for Supercomputing Appl.
Nick L. Weade
605 E. Springfield Ave.
Champaign, Illinois 61820
(217)244-5573

National Institute of Standards and Tech
David C. Stieren
Shops Bldg. 304 Room 142
Gaithersburg, MD 20899
(301)975-3197

National Security Industrial Association
Peter Castellas
1025 Connecticut Ave. N. W.
Suite 300
Washington, D. C. 20036
(202)775-1440

National System Management Corporation
E. Pierce
4600 Pinecrest Office Park Drive
Alexandria, VA 22314
(703)941-3914 X788

Naval Air Technical Services Facility
David Campbell
Production Engineering Detachment
Washington Navy Yard Washington, D.C. 20374-2300

Naval Supply Systems Command
Lorna B. Estep
1745 Jefferson Davis Hwy.
Crystal Square 4, Room 501
Arlington, VA 22241-5360
(703)607-3288

Nav Ind Res Sup Act
Leo Plonsky
700 Robbins Ave
Bld 10-2
Phila, PA 19111-5078
(215)697-9534

Naval Air Systems Command (AIR-4.2.1)
David Stefke
1421 Jefferson Davis Highway
Arlington, VA 22243-5120
(703)604-3440 x2610

Naval Air Systems Command (AIR-1.1)
R. Martin
1421 Jefferson Davis Hwy
Arlington, VA 22243-5120

Naval Air Systems Command (AIR-1.3)
Capt. Edward Mihalak
1421 Jefferson Davis Hwy
Arlington, VA 22243-5120
(703)604-6200 x3414

Naval Air systems Command (AIR-1.3A)
Gerald Cecala
1421 Jefferson Davis Hwy
Arlington, VA 22243-5120
(703)604-6200 x3415

Naval Air Systems Command (AIR-1.6.3)
Rich Swartwood
1421 Jefferson Davis Highway
Arlington, VA 22243-5120
(703)604-2300 x5458

Naval Air Systems Command (AIR-3.6.1.2)
Shawn MaGill
1421 Jefferson Davis Highway
Arlington, VA 22243-5120
(703)604-3090X4178

Naval Air Systems Command (AIR-4.10.3)
Jerry Goldblatt
1421 Jefferson Davis Hwy
Arlington, VA 22243-5120
(703)604-3380 x8117

Naval Air Systems Command (AIR-4.1.9)
Bob Tourville
1421 Jefferson Davis Hwy
Arlington, VA 22243-5120

NAVSEA - 0508
Kit Ryan
2531 Jefferson Davis Highway
NC2, Room 6W72
Arlington, VA 22242-5160
(703)602-8250
RYAN_KIT@HQ.NAVSEA.NAVY.MIL

Naval Air Warfare Center Indianapolis
Gary Lindberg
Nav Air Warfare Center-Air Div.
6000 E. 21st St.
Indianapolis, IN 46219-8189
(317)306-7047

Naval Air Warfare Center - Training Support Division
Capt. Mark Yerkes
12350 Research Pkwy.
Orlando, FL 32826-3224
(407)380-8102

Newport News Shipbuilding
Chris J. Joseph
Airport Plaza 1, Suite 1100
2711 S. Jefferson Davis Hwy
Arlington, VA 22202

NORTHROP
Jeff Barnett
B2 Division
8900 East Washington Blvd.
Pico Rivera, CA 90660
(301)942-5190
JBARNETT@NRTC.NORTHROP.COM

Northrop Grumman Commercial Aircr. Div.
William Rhoades
Mail Stop 49-61
P.O. Box 655907
Dallas, TX 75265-5907
(214)266-3068

Northrop Grumman
Dr. Mavis Lapins
Adv. Tech. Development Center
South Oyster Bay Rd.
Bethpage, N.Y. 11714-3582
(516)575-5224

Office of Naval Research
Steve Linder Code 362
800 North Quincy Street
Arlington, VA 22217-5660
(703)696-8483

Chief of Naval Operations (N6)
CAPT Kistler
2000 Navy Pentagon
Washington, D.C. 20350-2000
(703)614-4770

Chief of Naval Operations (N880E)
CDR Gary Peterson
2000 Navy Pentagon
Washington, D.C. 20350-2000
(703)614-3284

PEO (A)
Capt. Bill Fetzer
1421 Jefferson Davis Hwy
Jefferson Plaza 1-1138
Arlington, VA 22243-1013
(703)604-2966
FETZERWA@AM@NTRPS

Pratt & Whitney
Curt Cook
400 Main Street MS 118-38
East Hartford, CT 06108

Prior Data Services
Ron Sclenlader
340 Michael Cowpland Drive
Kanata, Ontario K2M 1P6
(613)591-7235

Purdue University
Dr. Chandrajit L. Bajaj
Dept. of Comp. Science
1398 Computer Science Bldg. Room 152
West Lafayette, IN 47907-1398
(317)494-6531

Raytheon
Fred Hembrough
Execution Offices
141 Spring Street
Lexington, MA 02173
(617)860-2281

Rockwell Science Center
Ken Fertig
444 High Street
Palo Alto CA 94301
(415)325-7773
fertig@rpal.rockwell.com

Rockwell Science Center Thousand Oaks
Laurie O'Connor
1049 Camino Dos Rios, P.O.Box 1085
Thousand Oaks, California 91358
(805)373-4321
ljo@risc.rockwell.com

San Antonio Electronic Commerce Resource Center
Janet Butch McGehee
4318 Woodcock Drive Suite 200
San Antonio, TX 78228
(210)735-1903

SPAWAR 31
Capt. Lee Dick
2451 Crystal Drive, RM 730
Arlington, VA 22245-5200
(703)602-2791
DICKL@SMTP_GWSPAWAR.NAVY.MIL

SPAWAR 31A
G. Melcher
2451 Crystal Drive, RM 730
Arlington, VA 22245-5200

Stanford CDR
Mark R. Cutkosky
Dept. of Mechanical Engineering, Stanford Univ.
Stanford, CA 94305-4021

Step Tools Inc.
Martin Hardwick
Rensselaer Technology Park
Troy, NY 12180
(518)276-2712

Tank Automotive Research, Dev, & Eng.
Mr. Ralph Keith
Warren, MI 48397-5000
(810)574-5066

Texas Instruments
Ralph Schwartz
6600 Chase Oaks Blvd.
Bldg 3, MS 8497
Plano, TX 75023
(214)575-5073

Theater Air Defense/PEO
Dr. Ed Baker
National Center 2 / 9W62
2531 Jefferson Davis Hwy.
Arlington, VA 22242-5170
(703)602-1822

United Defense FMC/BMY
Darryl Satten
1205 Coleman Ave.
Santa Clara, CA 95050

United Technologies Sikorsky Aircraft
Paul W. Von Hardenburg
6900 Main Street P.O. Box 9729
Stratford, CT 06497-9129
(203)386-7803

University of Maryland
Dr. Ioannis Minis
Dept. Of Mechanical Engineering & Institute for Systems Research
College Park, MD 20742
(301)405-5310

University of Central Florida
Ernie Smart
Institute for Simulation & Training
3280 Progress Drive
Orlando, FL 32826
(407)658-5014

University of Iowa
Dr. Jon G. Kuhl
Center for Computer-Aided Design
208 Engineering Res. Facility
Iowa City, Iowa 52242-1000
(319)335-5048

U.S.A.F. Manufacturing Technology
Michael F. Hitchcock
WL/MTIM Bldg. 653
2977 P Street, Suite 6
Wright Patterson AFB, OH 45433-7739
(513)255-7371

USAF WL/MTA
Dilip Punatar
WL/MTA, Bldg 653
2977 P St. Suite 6
Wright Patterson AFB, OH 45433-7739
(513)255-3920 x259

Virtual Prototypes
Paul A. Barnett
4700 de la Savane, Suite 300
Montreal, QC, Canada H4P 1T7
(514)341-3874

Westinghouse
George Reynolds
PO Box 746 MS 1220
(410)993-7113

Venkat Devarajan
P.O. Box 19016
The University of Texas at Arlington
Arlington, TX 76019
(817)273-3485
venkat@uta.edu

John Balderston
Lockheed Martin Aeronautical Systems
86 South Cobb Drive
Marietta, GA 30063-0581
(770)494-8341
jb.alders@asc.lockheed.com

Return to Table of Contents

Appendix C

Government and Industry Development Programs

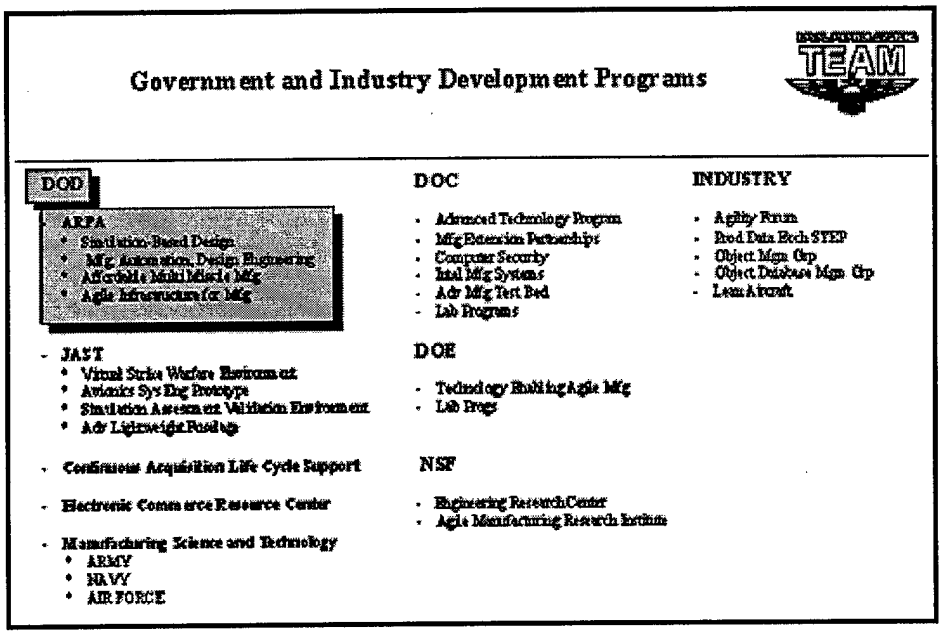
ADVANCED RESEARCH PROJECTS AGENCY

The Advanced Research Projects Agency (ARPA) is leading DoD in developing technologies that support the distributing computing and collaborative design environment. The Simulation Based Design Program (SBD) is developing and demonstrating technologies to support the distributed, collaborative infrastructure. The SBD program is developing technologies applicable to all complex weapon systems but is focusing their technology demonstrations on shipbuilding applications. A working group has been formed by the ASN's office for acquisition reform to facilitate the transfer of this technology to the Naval Systems Commands.

In addition, ARPA is sponsoring the Manufacturing, Automation, Design, and Engineering (MADE) program, the Affordable Multi Missile Manufacturing (AM3) program, and the Agile Infrastructure for Manufacturing (AIM) program. The MADE program intends to develop tools and technologies that will allow the designer to explore an order of magnitude more designs in half the time it takes to explore a single alternative design using today's capability. MADE will leverage several technologies such as knowledge sharing, expert planning and scheduling, knowledge-based CAD/CAE, and intelligent agents to develop the infrastructure for an agile design environment. MADE has demonstrated the feasibility of collaborative design projects on the Internet. Additional information can be found on the world wide web at HTTP://ELIB.CME.NIST.GOV/MADE/MADE.HTML

The AM3 program is implementing a collaborative infrastructure for the development and production of missiles for the Army, Navy, and Air Force. Program goals are to reduce costs of ongoing missile programs by 25%; reduce the development and production cost of new missiles and major upgrades by 50%; reduce the dependence of unit cost on lot size; reduce the development cycle times by at least 50%; and maintain or increase the quality and performance to levels that are acceptable to specific missile systems. Additional information can be found on the world wide web at HTTP://WWW.SAINC.COM/ARPA/AM3.

The AIM program is an agile manufacturing pilot program focused on developing tools for agile manufacturing within the aerospace industrial base. The AIM program provides for a prototype virtual corporation; a scalable support infrastructure; a template for agile business transactions over the internet; procedures and metrics for certifying agile suppliers; and metrics for managing a virtual corporation. A component of the AIM program will link the production facilities of aircraft manufactures so that files which operate numerically controlled equipment can be transferred among organizations for the purposes of sharing production assets. Additional information can be obtained from Ram Sriram at 415 354-5203 e-mail sriram@aic.lockheed.com



GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

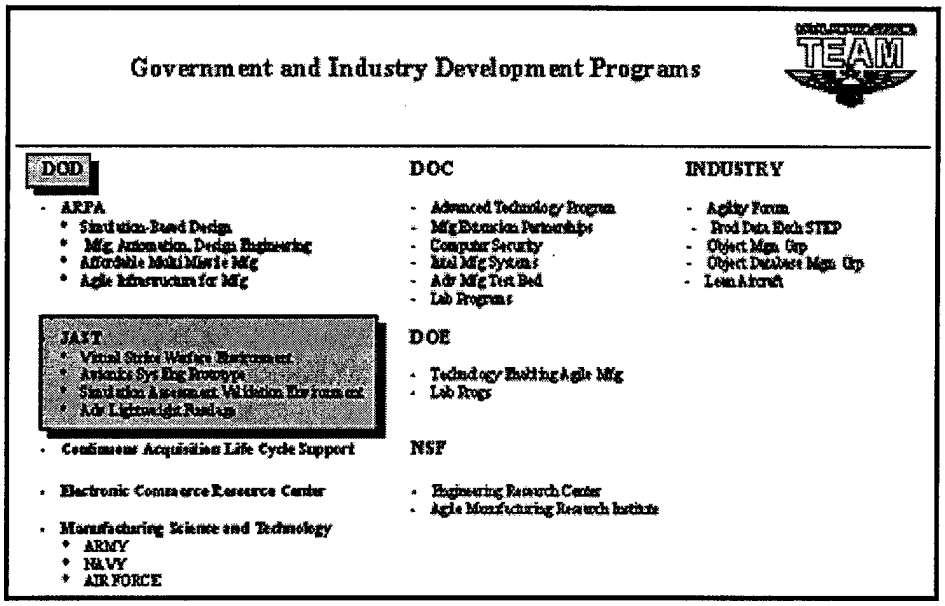
JOINT ADVANCED STRIKE TECHNOLOGY

The Joint Advanced Strike Technology (JAST) Program Office's mission is to create affordable strike warfare systems by facilitating development of fully validated and affordable operational requirements; facilitating maturation of leveraging technologies; and demonstrating leveraging technologies (products and processess) and operational concepts. Many of these technologies are directly applicable to the development and production of the Common Support Aircraft. The Virtual Strike Warfare Environment (VSWE) provides a warfare environment for strike that includes AEW and CEC functions. VSWE models and simulates threats, tactics, strike environments factors, offboard data transfer, and other factors pertinent to a warfighting environment and is mainly used in campaign and engagement analyses.

The Avionics System Engineering and Prototyping (AVSEP) program in JAST evaluates and refines avionics concepts. The program will define and demonstrate architecture and avionics concepts that achieve the lowest cost/performance ratio and ensure readiness for low-risk transition to EMD. AVSEP provides for a collaborative environment for integrating the aircraft's avionics with the airframe structure through associate contract agreements with the prime weapon systems contractors. Virtual avionic prototypes are used to validate these concepts within AVSEP.

Simulation Assessment Validation Environment (SAVE) Project will integrate technology and conduct demonstrations to optimize the manufacturing processes associated with JAST. SAVE's objectives are to integrate and mature a set of computer-based modeling and simulation tools that predict manufacturing cost/risk; evaluate alternative designs and processes; and provide for decision support during product development. Examples are Deneb's IGRIP (process simulation), and Unimation's PLACE (numerically controlled machine simulation. The Advanced Lightweight Aircraft Fuselage Structure (ALAFS) is a project under SAVE that will demonstrate a unitized composite fuselage of an F/A-18.

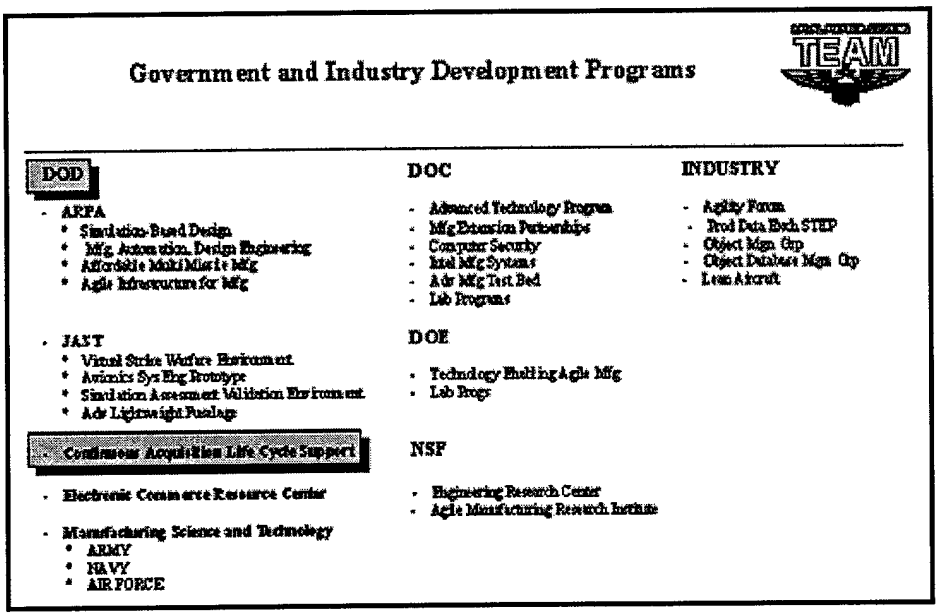
Additional information on JAST is available on the world wide web at HTTP://WWW.JAST.MIL



GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

CONTINUOUS ACQUISITION LIFE CYCLE SUPPORT

The vision of the CALS Industry Steering Group initiative is to enable integration of enterprises on a worldwide basis where an original equipment manufacturer and its suppliers are able to work from a common digital data base, in real time, on the design, production, distribution, and servicing of the product. Basic tenets of the initiative assume an open systems software environment, and the adoption of international standards. Within DoD the CALS program has developed a strategy to share digital product data though a set of standards that contribute to the development of an integrated data environment (IDE). The IDE is defined as the business environment created by the application of existing national and international standards, practices, and technologies to automate the management and exchange of information. CALS recognizes that affordable, readily accessible, and timely technical data is critical to the acquisition process. CALS has developed the Joint Engineering Data Management Information and Control System (JEDMICS) and Joint CALS (JCALS). JEDMIS is the DoD standard system to store, manage, and distribute engineering drawings and related technical data in digital form. The system indexes, stores, and retrieves the data digitally, and can distribute it in several ways including hard copy, aperture card, optical platter and magnetic tape. JCALS is an information systems program that provides for the infrastructure to give DoD the capability to create, manage, use, transfer, and store acquisition and logistics technical information in a digitized format. Additional information can be found on the world wide web at HTTP://WWW.ACQ.OSD.MIL/CALS



GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

ELECTRONIC COMMERCE RESOURCE CENTER (ECRC)

ECRCs were created by Congress to assist small to medium size manufacturing firms keep pace with rapidly evolving technologies and business practices. ECRCs promote awareness and implementation of Electronic Commerce (EC) and related technologies into the domestic civil-military industrial base, to help manufacturers improve their competitive posture in global markets and strengthen the domestic industrial base.

Each of the eleven ECRCs funded and managed by ARPA, support outreach, education and training, consultation and technical support programs to identify and meet individual customer needs. Their customers are the small to medium size U.S. manufacturers; government prime contractors assisting in supplier chains; government agencies involved in acquisition; educational institutions; and manufacturing extension providers, including small business development centers, economic development organizations, procurement assistance centers, state extension programs, and the National Institute of Standards and Technology (NIST) Manufacturing Extension Partnership (MEP) Centers.

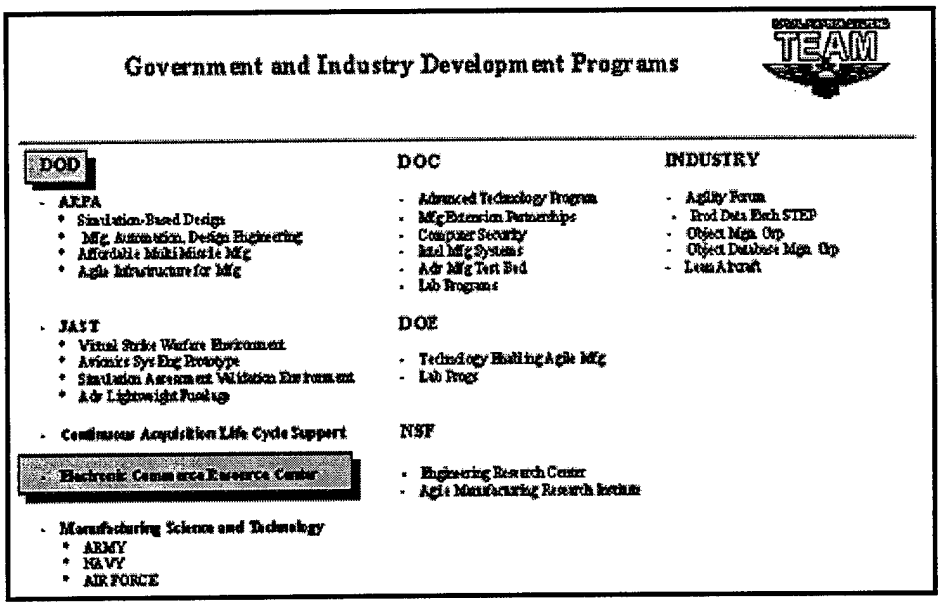
ECRCs are normally made up of one or more companies in consortium with a local university: the Fairfax Regional ECRC which is operated by Dimensions International Inc. in consortium with George Mason University and the Orange Regional ECRC (http://www.kbsi.com/ecrc/ecrc.html) operated by KBSI. It exists as a virtual enterprise composed of KBSI (the prime contractor), Information Assets, Inc. (IAI), Science Applications International Corporation (SAIC) and Lamar University-Orange, TX.

Outreach provides the initial contacts with domestic manufacturers and results in customer awareness of the potential of electronic commerce. It is intended to lead to consultation and technical support.

Education and training - Courses include: CALS orientation including initiative and integration manufacturing, CALS in government procurement, and ISO 9000; EDI orientation; Integrating Integrated Definition (IDEF) methods with CALS; Legacy data management; concurrent engineering; graphics and CALS graphics standards; getting started in electronic commerce; standard generalized

markup language (SGML); business needs analysis; process management in a technology environment; data in a business environment; EDI implementation; recovering design data from manufactured parts.

Consultation and technical support start with analysis to develop a baseline understanding of a company's needs and operations, and to identify problems that can be resolved by EC technologies. After the baseline is defined, a list of candidate technical support projects and recommendations are presented. Once the consultation leader recommends a company to receive technical support, a consultation team conducts a detailed analysis of viability. If technical support is warranted, the technical support team develops a detailed list of solutions and an application plan for the company.



GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

MANUFACTURING SCIENCE & TECHNOLOGY

The DoD Manufacturing Science and Technology (MS&T) Program began as the Manufacturing Technology (MANTECH) Program in the late 1960s. Manufacturing technology encompassess the application of science and technology to the production of affordable, quality products. The DoD MS&T Program is managed by the Director, Defense Research and Engineering (DDR&E). The Joint Directors of Laboratories (JDL) Technology Panel for MS&T is chartered to identify and integrate requirements, conduct joint program planning, develop joint strategies, and oversee the execution of the MS&T Programs. In FY95 $6.2 billion was spent on these programs. Within the services the Manufacturing Science and Technology Programs of the Army, Navy, and Air Force have efforts in composites structures, high speed machining, and virtual manufacturing.

The Navy MS&T is one element of the DoD MS&T Program and is managed by the Office of Naval Research who is responsible for the identification of production deficiencies within the Defense industrial base, the development of solutions, and the implementation of these solutions in a factory or depot environment. The Naval Systems Commands have MS&T program offices that are responsible for the planning, execution, and implementation of the MS&T projects within their mission areas:

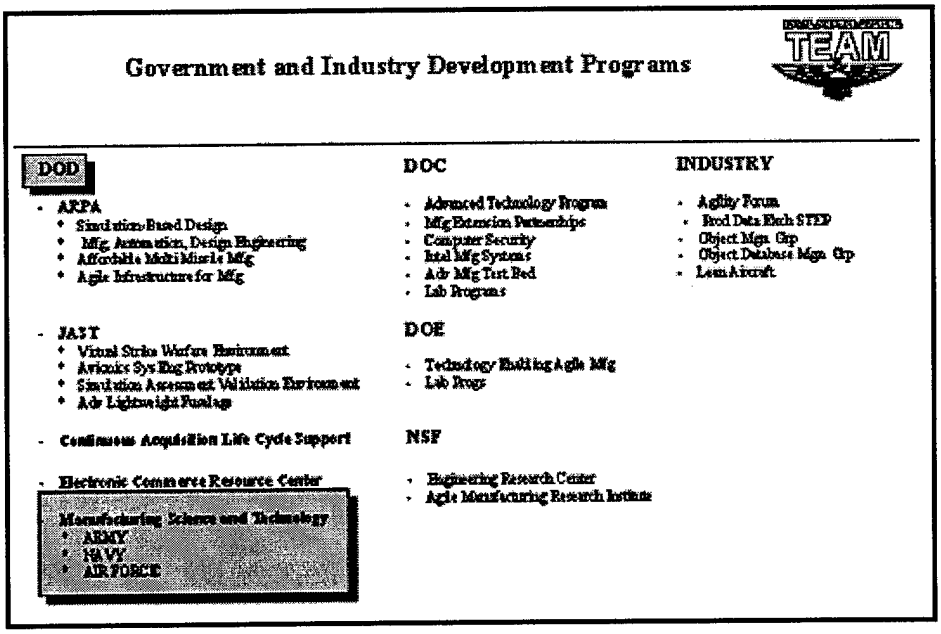
- Naval Air Systems Command
  Airframes, Propulsion, Avionics, Microwave Devices, Electro-Optics, and Solid State

Technology;

- Naval Sea Systems Command
  Ship Construction and Overhaul;

- Naval Supply Systems Command
  Rapid Acquisition of Manufactured Parts (RAMP);

The Manufacturing Technology Information Analysis Center (MITAC) is a DoD resource whose objective is to collect, analyze, and disseminate timely information on the characteristics and use of manufacturing technologies for production of defense materials. The MITAC may be contacted at 1 800 421-0586 for advice and assistance in securing copies of final reports on MS&T projects. Additional resources include the Navy MS&T Centers of Excellence and the Best Manufacturing Practices (BMP) Program.



GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

DEPARTMENT OF COMMERCE

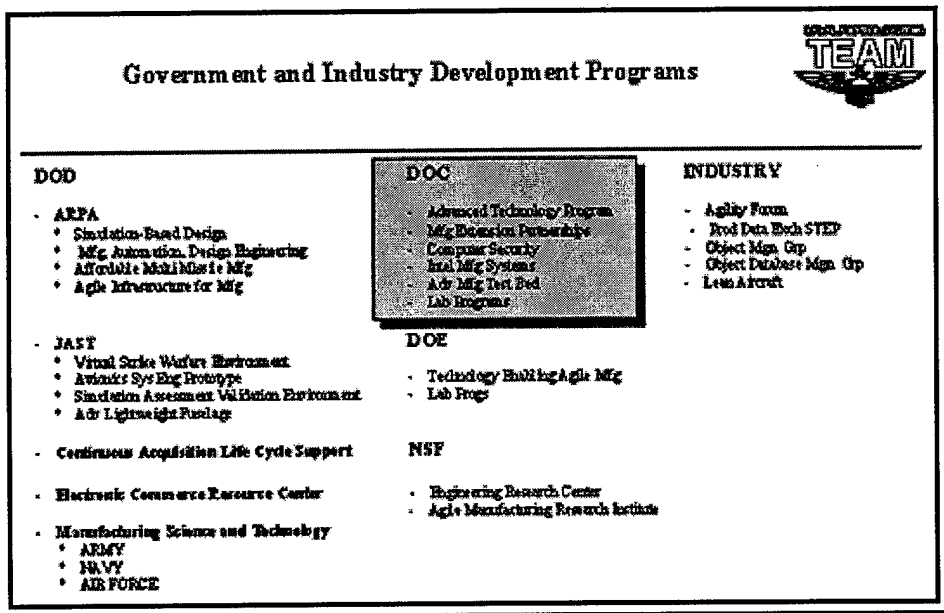
The Department of Commerce has the Advanced Technology Program, the Manufacturing Extension Partnerships, Computer Security, Information Driven Manufacturing, Advanced Manufacturing Testbeds, and many other NIST laboratory programs. The NIST Advanced Technology Program promotes the economic growth and competitiveness of U.S. industry by accelerating the development of high-risk technologies. The program provides funding for technology development through cooperative research agreements to single businesses or industry led joint ventures. Research goals of past award winners include development of thick-film processing technology for radio-frequency components; development of dry, gas-phase agents in lieu of wet chemicals to clean semiconductor wafers; demonstration of high-precision, multi-axis machine tools based on an octahedron frame and a "Stewart" platform actuator.

The Manufacturing Extension Partnership (MEP) is a growing nationwide system of services and support geared towards smaller manufacturers. Small and mid-sized manufacturing firms account for more than half of the total value of U.S. production in dollars and nearly two thirds of all workers. Each MEP is a private, non-profit organization not affiliated with a state or the federal government that forms a partnership with industry, educational institutions, and government agencies. There are 42 centers operating in 32 states that provide links to sources of improved manufacturing technology to small and mid-sized companies. The centers encourage client companies to establish programs for continuous improvement and to focus on long-term impacts.

The Computer Systems Laboratory is funding several efforts within their Computer Security Program including: computer systems security; security in ISDN and OSI networks; malicious code and related threats; and data encryption. Within the data encryption project, NIST is working with industry to advance standards and develop technology in computer cryptography.

Automated intelligent-processing tools for manufacturing are being developed within the Manufacturing Engineering Laboratory at NIST. Components include intelligent machines; advanced sensors for real-time in-process measurements; software for precision control of machine tools; and information technology for integrating all elements of a product's life cycle. NIST is also developing the National PDES (Product Data Exchange using STEP) Testbed to provide a testing-based foundation for rapid and complete development of products based on STEP.

Additional information on these programs can be found on the world wide web at HTTP://WWW.NIST.GOV/



GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

DEPARTMENT OF ENERGY

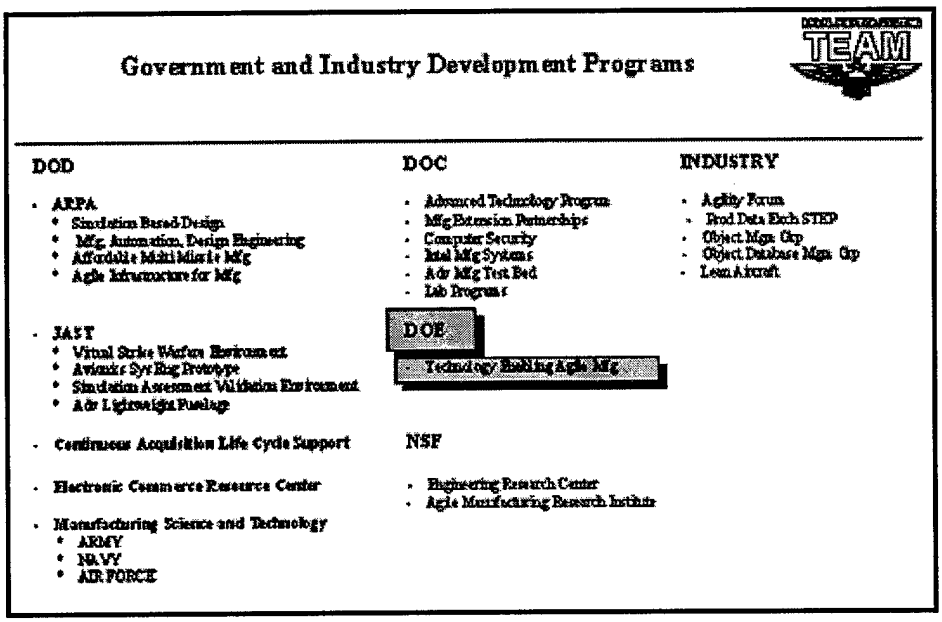
The Department of Energy initiated the Technology Enabling Agile Manufacturing (TEAM) program in 1992 to enhance the national industrial competitiveness by advancing and deploying manufacturing technologies that promote agility. TEAM promotes synergy between private industry and the DOE facilities and dovetails its activities with ongoing programs within DoD, NIST, and NSF. TEAM focuses on advancing pre-competitive leap-ahead technologies from which many industries can

benefit through shared investment. More than 25 industry companies participate, along with five DOE facilities, DoD components, NIST, NSF, and a number of universities. TEAM is developing technologies in five thrust areas: Product Design & Enterprise Concurrency; Virtual Manufacturing; Manufactfacturing Planning & Control; Intelligent Closed-Loop Processing; and Integration. The thrust areas should develop leap-ahead capabilities that:

- Replace serial design and manufacturing engineering with integrated concurrent processes that eliminate redundant design and greatly reduce time-to-market.
- Replace expensives expensive trial-and-error prototyping on the factory floor with inexpensive, rapid virtual prototyping of products and manufacturing processes in simulated factories.
- Slash material, rework, and scrap costs by optimizing designs for performance and producibility before they reach the shop floor, and by ensuring quality in manufacturing processes through intelligent closed-loop control.

TEAM will demonstrate the agile manufacturing tools it develops for three high-priority processes that were identified by industry: material removal; sheet metal forming; and electronic/electromechanical assembly.

Within the DoE laboratory system (Sandia, Oak Ridge etc.) there are many advanced manufacturing technology efforts that could be applied to the construction of aircraft and weapon systems. Additional information can be found on the world wide web at HTTP://CEWWW.ENG.ORNL.GOV/TEAM/HOME.HTML.



GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

NATIONAL SCIENCE FOUNDATION

Within the university environment, the National Science Foundation (NSF) is providing projects in Engineering and Manufacturing Research. NSF is sponsoring the Engineering Research Centers (ERC) Program and the Agile Manufacturing Research Institutes Program. The ERC program is a

cross-disciplinary research and education program focused on competitive issues in engineering systems. ERCs are located at academic institutions and are chartered to improve the contribution of engineers to competitiveness, promote cross-disciplinary team work, and experiment with engineering test beds. Existing ERCs include:

Engineering Design Research Center

ERC for Particle Science and Technology

Optoelectronic Computing Systems Center

Columbia ERC

Center for Compound Semiconductor Microelectronics

Center for Advanced Technology for Large

Institute for Systems Research

Structural Systems

Computational Field Simulation

ERC for Net Shape Manufacturing

Center for Plasma Aided Manufacturing

Software Engineering Research Center

ERC for Collaborative Manufacturing

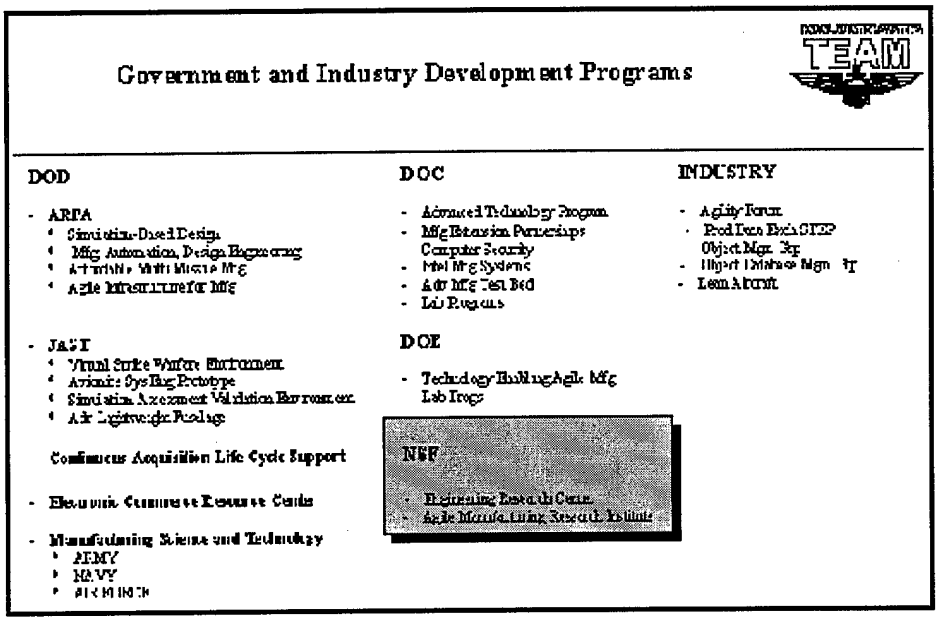
Center for Interfacial Engineering

Additional information is available on the world wide web at HTTP://WWW.NSF.GOV

Three Agile Manufacturing Research Institutes have been selected:

- Machine Tools, MT-AMRI University of Illinois
- Rensselaer's Electronics Agile Manufactfuring Research Institute
- Agile Aerospace Manufactfuring Research Center, AAMRC University of Texas at Arlington.

MT-AMRI is a virtual research center that is a strategic alliance of industry, government, and academia dedicated to the advancement of technologies related to the design, manufacturing, and utilization of machine tools. The Agile Aerospace Manufacturing Research Center (AAMRC) is located within the Automation & Robotics Research Institute (ARRI) at the University of Texas, Arlington. AAMRC conducts research on agile business practices, processes, and technologies for the aerospace industry. It is the only AAMRC dedicated to the Aerospace industry. Additional information can be obtained from John Meyer, NSF, 703-306-1390, e-mail jmeyer@nsf.gov.



GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

INDUSTRY CONSORTIA

Industrial consortia are focusing on the development of standards and manufacturing practices to help American industry compete in the world market. Standards are being developed by PDES Inc. and OMG, while manufacturing practices are being identified by the Agility Forum, the Lean Aircraft initiative, and Consortium for Advanced Manufacturing International (CAM-I).

AGILITY FORUM

The Agility Forum was established in 1991 to provide national leadership in the area of Agile competition. The Forum is a clearinghouse for the collection and dissemination of information contributing to a broader understanding of Agility. The vision of the Agility Forum is to be recognized as the center for preparing American enterprise for leadership in the global transformation to agility. It is industry led and industry supported. Additional funding is provided by a grant from the National Science Foundation.

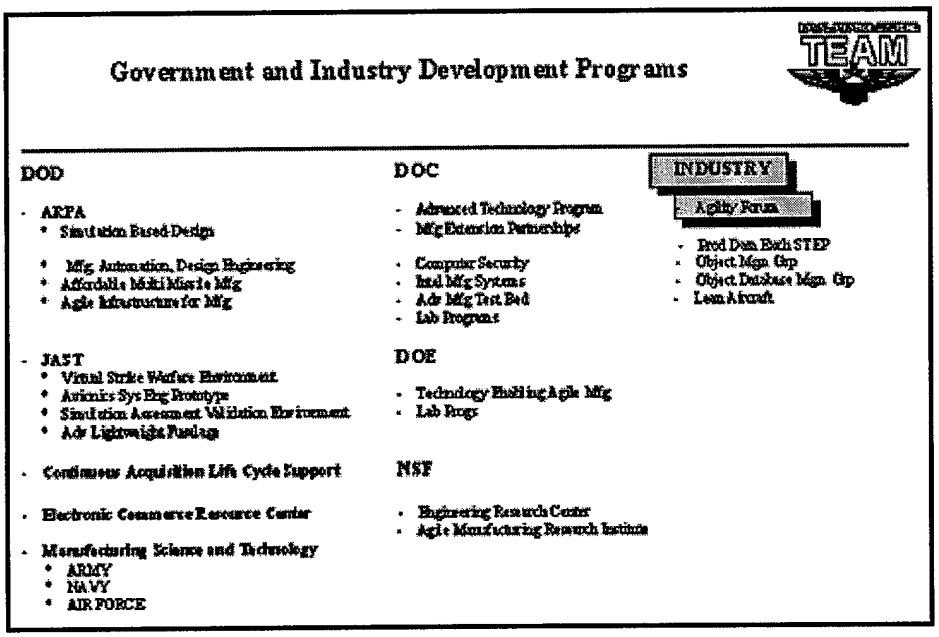
Agility in this context, is the ability to thrive and prosper in a competitive environment of continuous and unanticipated change, to respond quickly to rapidly changing markets driven by customer-based valuing of products and services. Originally conceived as a tool for manufacturing, Agility has found applications in all sectors of economy.

Agility in the manufacturing field affords a wider and more competitive production base. With the inception of the agile manufacturing concept, it is conceivable that new programs, such as the CSA, can come to fruition in a much shorter period of time. Through a standard means of communication and the flexibility afforded in using the agile manufacturing concept, collaboration can be achieved for research, design, virtual concept and production. Not only does this reduce development time, but it also provides a broader array of producers that in the past may have been confined to specific products. This approach does not come about without cost. The initial cost of modern manufacturing equipment, flexible manufacturing systems, the CAD/CAM systems to drive the equipment and trained employees to operate this equipment may not be within the means of many product producers. Those that have made

this investment offer the customer a product of higher and more consistent quality in a shorter period of time. Additionally, it gives the customer more control over his requirements through a collaborative environment, (i.e., having real-time input to design, changes, options, and cost).

Specific Goals of the Agility Forum are as Follows:

- Deepen the understanding of agile organizations for American businesses by facilitating self-discovery.
- Speed the implementation of agile capabilities.
- Provide a consistent understanding of agility to a broad base of American businesses through written, electronic, and other means.
- Help organizations measure progress toward agility.
- Help industry and government identify and remove obstacles to agile organizations by facilitating self-discovery.
- Prepare all human resources to excel in agile environments by creating training programs.
- Identify necessary technology enablers by working with industry.
- Help small and medium-sized business in America become agile with "bootstrap" programs.



GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

PRODUCT DATA EXCHANGE USING STEP (PDES, INC)

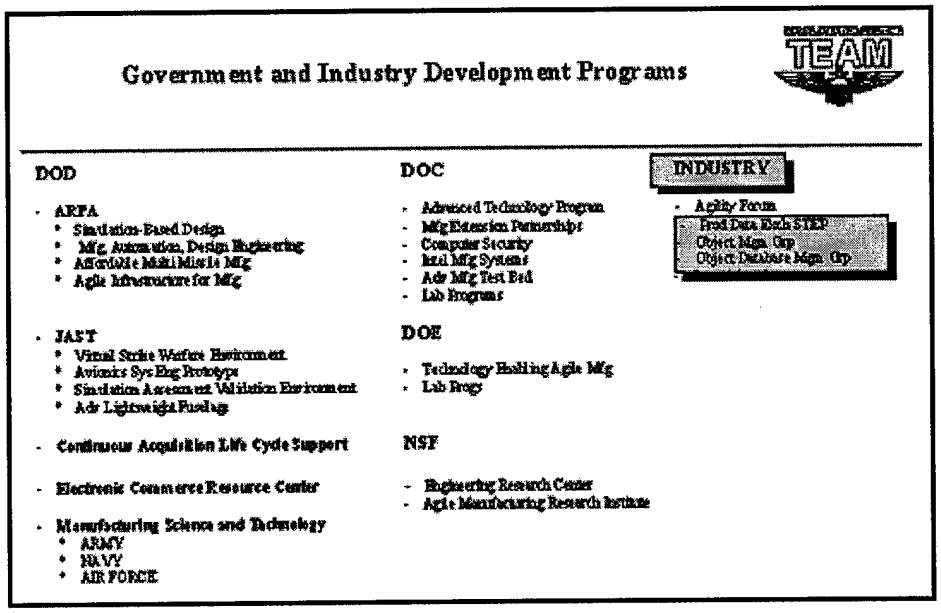
PDES, Inc is an international industry/government consortium accelerating the development and implementation of STEP - STandard for the Exchange of Product model data (ISO 10303). STEP enables companies to exchange product information with their partners, associates, subcontractors, suppliers, etc. STEP defines product information models and standards. Data "models" include geometry and topology, dimension and drafting, material and specifications, product structure, configuration management and effectivity, approvals, change request, change order, work request, work order, and many more. STEP supports design reuse, data retention, and provides access to data across a product's life cycle. Additional information is available on the world wide web at HTTP://WWW.SCRA.ORG/PDESINC.

OBJECT MANAGEMENT GROUP

The Object Management Group (OMG) is a non-profit consortium dedicated to promoting the theory and practice of object technology for the development of distributed computing systems. OMG's goal is to provide a common architecture framework for object oriented software applications based on open system specifications. Conformance to OMG's specifications will enable a heterogeneous application environment across hardware and operating systems. OMG published the Object Management Architecture (OMA) Guide which represents the vision of a distributed computing architecture capable of supporting global multi-vendor networks. The OMA defines the primary parts of any object-oriented computing environment beginning with the object request broker. The object request broker is a communications mechanism that enables objects to send and receive messages. Also defined within the OMA were object services, common facilities, and application objects. Current OMG membership exceeds 500 companies. Additional information can be found on the world wide web at HTTP://WWW.OMG.ORG.

OBJECT DATABASE MANAGEMENT GROUP

The Object Database Management Group (ODMG) is a consortium of object oriented database management systems (ODBMS) vendors developing standards to permit portability of software across ODBMS products. ODMG-93 specification has been published and covers the basic capabilities needed for an application to use an ODBMS, to create, modify, and manage objects. Applications written to this interface standard will operate across all compliant ODBMS implementations. Continued releases of the specification are anticipated that will increase functionality and map to additional languages besides C++ and Smalltalk. Additional information is available on the world wide web at HTTP://WWW.ODMG.ORG



GOVERNMENT AND INDUSTRY DEVELOPMENT PROGRAMS

LEAN AIRCRAFT INITIATIVE

The Lean Aircraft Initiative (LAI) is an MIT research project patterned after the highly successful

Lean Automotive Initiative which was used by the automotive industry to recapture the U.S. and world markets. The LMI is a three-year collaborative effort with government and industry which began in 1993. The focus of the effort is on data, analysis, benchmarking, and implementation of lean aircraft principles. The project's resources are derived from industry at a rate of $75K per company per year, and from Government at a rate of $975K per year. The individual participants incur the cost of surveys, workshops, case studies, and implementation.

The following are the five elements of a lean enterprise:

1. Lean Management
2. Lean Customer Relations
3. Lean Supplier Relations
4. Lean Development
5. Lean Factory Operations

Government and Industry Development Programs

DOD

- ARPA
  - Simulation Based Design
  - Mfg Automation, Design Engineering
  - Affordable Multi Missile Mfg
  - Agile Infrastructure for Mfg
- JAST
  - Virtual Strike Warfare Environment
  - Avionics Sys Eng Prototype
  - Simulation Assessment Validation Environment
  - Adv Lightweight Fuselage
- Continuous Acquisition Life Cycle Support
- Electronic Commerce Resource Center
- Manufacturing Science and Technology
  - ARMY
  - NAVY
  - AIR FORCE

DOC

- Advanced Technology Program
- Mfg Extension Partnerships
- Computer Security
- Intel Mfg Systems
- Adv Mfg Test Bed
- Lab Programs

DOE

- Technology Enabling Agile Mfg
- Lab Progs

NSF

- Engineering Research Center
- Agile Manufacturing Research Institute

INDUSTRY

- Agility Forum
- Prod Data Tech STEP
- Object Mgm Grp
- Object Database Mgm Grp
- Lean Aircraft

Return to Table of Contents

Appendix D

Applicable Products and Programs Listed and Discussed Alphabetically

Agile Integrated Manufacturing Service (AIMS)

POC: Dr. Mark Cutkosky
cutkosky@sunrise.stanford.edu

Objective: AIMS is a shared machine tool environment where manufacturers can use CNC tools in other facilities to enhance their in-house production when needed. Product files are downloaded to facilities for supplemental manufacturing enhancement.

Performing Organization: AIMS is an Agile program conducted by Lockheed, TI, Rockwell, National Machine Tool Association, Stanford, and Lawrence Livermore.

Benefit to CSA: AIMS could be a significant resource to any collaborative aircraft program. With such an environment, any designer, regardless of his/her own companies resources, could quickly produce a part using the resources of any contractor participating in the same program. AIMS expands the ability of individuals in a collaborative effort to produce.

Maturity: This technology is expected to rapidly mature over the next three years.

ARENA

POC: Bob Van Siclen
214-603-9405

Objective: ARENA simulates the equipment and process of a factory floor. It includes Simon, a human factors model for balancing manpower loading. Together, these simulations can be used to identify problems and optimize a manufacturing process prior to the construction of an assembly line.

Performing Organization: Loral Vought

Benefit to CSA: ARENA could enable CSA to optimize the factory floor plan prior to its construction. ARENA is an example of the many manufacturing initiatives under way that will contribute to significantly reducing the cost of the CSA. These types of initiatives need to be monitored by Naval Aviation Team personnel and applied to programs such as CSA.

Maturity: ARENA is being used for a number of projects like ATACMS and PAC-3. Loral Vought is in the process of linking ARENA with Purdue University's Art-to-Part CAD system "Quick Turnaround Cell"(QTC).

Art-To-Part Composite Fabrication Facility

POC: Doug Wolfe
214-266-5209

Objective: Northrop/Grumman/Vought Commercial Aircraft Division demonstrated the ability to design composite components using a commercial CAD system, optimize the composite fiber placement, and automatically download to a fiber tape laying machine.

Performing Organization: Northrop/Grumman/Vought Commercial Aircraft Division

Benefit to CSA: This system should help reduce the cost of composites for lightweight airframes on low observable aircraft.

Maturity: Vought is actively using this technology in their fabrication facility near Dallas.

Butch

POC: Robert Brown
810-377-6900

Objective: Butch is a COTS tool developed by Deneb Robotics to facilitate human factors testing and analysis. It provides designers the ability virtually to test a design's functionality. This includes issues such as field of view, reach, access to controls, and interference. Problems not obvious prior to full-scale mockup, such as cockpit accommodation of a pilot or interference between a human and a design component are identified.

Performing Organization: Deneb Robotics

Benefit to CSA: Human Factors design analysis tools are necessary whenever a design includes human-machine interaction. Butch could assist CSA developers in developing an aircraft that maximizes the effectiveness of pilot, crew, and ground handlers.

Maturity: A good fully developed human factors tool. It is actively being used by General Dynamic's Electric Boat Division. Butch should be examined by CSA developers for inclusion as a human factors design and analysis tool for cockpit design, maintenance accessibility, workflow analysis, etc. on the CSA.

Carnot/Infosleuth

POC: Lyle Welti
512-338-3426
http://www.mcc.com:80/projects or http://www.einet.net

Objective: Carnot is a tool designed to make information that is physically distributed across an enterprise more readily accessible. It is sponsored by Motorola, TI, Computing Devices International, and Hughes Aerospace. The development of Carnot started in 1990 and concluded in December of 1994 with the beginning of the second generation project Infosleuth. Infosleuth is an intelligent agent personalized to communicate with other intelligent agents and computers to find, broadcast, and manage information for its user. The Infosleuth project will also access physically distributed information using semantic agents on the Web.

Performing Organization: Microelectronics and Computer Technology Corp. (MCC)
Benefit to CSA: Carnot and Infosleuth each have potential application to both government and commercial CSA contractors as an information manager and distributor.

Maturity: Carnot is a first generation product which at the time of the site visit, late March 1995, was in the process of being commercialized. It is intended to commercialize Infosleuth as well.

Close Combat Tactical Trainer (CCTT)

PM CATTPOC: John R. Collins
407-380-4382
collinsj@stricom.army.mil

Objective: CCTT is the replacement for SIMNET. It will include networked man-in-the-loop modules, distributive processing, visual-based battlefield, combined arms/collective training, force-on-force free play simulation, after action review and fixed and mobile versions.

Performing Organization: U.S. Army Simulation, Training and Instrumentation Command (STRICOM)

Benefit to CSA: Lessons learned during CCTT development could assist implementation of CSA's CVP efforts.

Maturity: CCTT is currently under development.

CADKEY Professional

http://www.cadkey.com/cadkey.htm

Objective: CADKEY Professional is a CADKEY product bundle that offers complete, integrated 3-D wireframe, surface and solids modeling capabilities for use with a personal computer. The bundle includes CADKEY 7, a windows 2-D and 3-D mechanical design and drafting solution; CADKEY Analysis, an integrated boundary element method-based analysis module; an Advanced IGES data translator; the CADKEY Advanced Modeler, a hybrid solids modeler; FastSURF, a third party 3D surfacing package from FastSURF, Inc.; and DRAFT-PAK, a third-party drafting enhancement package from Baystate Technologies. CADKEY Professional costs $1,595 and can be ordered over the www.

Performing Organization: Cadkey, Inc.

Benefit to CSA: CADKEY Professional is an example of an integrated CAD system including surfacing and analysis applications as well as an IGES translator to assist further integration with other systems. This technology is representative of the type of low-cost CAD systems available to small manufacturers that will enable, efficient virtual prototyping in a collaborative environment. The use of low-cost CAD systems and standards for the exchange of technical data such as IGES and STEP will significantly reduce the design and production time of CSA components. CADKEY Professional is an example of how the cost of this technology has dramatically fallen and its availability to small manufacturers and designers. CSA contractors should strongly encourage their suppliers to adopt inexpensive electronic CAD systems that are interoperable with their CAD system. All CSA team members should be 100% electronic-based.

Maturity: CADKEY Professional is a composition of Cadkey, Inc.'s active product line. Their DOS version of CADKEY 7 has had over 140,000 circulated copies worldwide.

Virtual Reality Driving Simulator CAVE

POC: Robert Berdine
309-578-6528
mosaic@ncsa.uiuc.edu

Objective: The National Center for Super Computing (NCSA) at the University of Illinois has been working with Caterpillar since 1991 on virtual reality, simulation, and computing research. The system developed by NCSA is a virtual reality driving simulation system. Vehicle simulation, visualization, and COTS graphics software modules have been integrated by NCSA into a seamless simulation environment. Software modules include 1) control and sensor simulation for feed into the virtual reality system and feedback to the operator, 2) vehicle simulation for kinematics of the vehicle, 3) soil simulation for real-life replication of ground soils, 4) sound simulation for replication of the operator's environment, and 5) graphics presentation software.

NCSA personnel have developed three configurations of the virtual reality system: 1) a desktop workstation version; 2) the "immersion desk," which is a large, single-projected screen; and 3) the three-walled CAVE, which has three large projection screens (front wall, left side wall, and floor).

Performing Organization: NCSA/Caterpillar

Benefit to CSA: The CAVE simulator exhibits potential for the following applications: 1) evaluation of machine performance such as control algorithms, 2) concurrent design and testing of alternate vehicle configurations, 3) ergonomic human-machine interface testing 4) training and safety evaluations, 5) evaluation of vehicle serviceability and, 6) evaluation of manufacturing processes such as robot clearances requirements.

Maturity: All three systems are continually being improved upon. An ultimate system that NCSA envisions is a full six-walled CAVE with platform motion; NCSA is seeking interest from potential users.

Conceptual Design Space

POC: Larry Hodges
404-894-8787
hodges@cc.gatech.edu

Objective: The Graphics, Visualization, and Usability Center (GVU) at Georgia Tech is working with the College of Architecture to create a Conceptual Design Space. They are demonstrating the use of virtual reality in support of Architectural design activities. The system is using 3-D tools to support the design activities in an immersive space. The system uses Wavefront as the graphical animation system and for simple CAD functions. They also use a head-mounted display, gloves, and a 3-D mouse. The program is working to integrate a virtual reality system into a CAD package. This is similar to the Polyshop effort at the IST at UCF. It is also similar to the University of North Carolina's Isac, the University of Virginia's Worlds in Miniature (WIM), and Stanford's Design Space.

Performing Organization: Georgia Institute Of Technology (Georgia Tech)

Benefit to CSA: The Conceptual Design Space could provide the CSA with a common workspace within which designers could work collaboratively.

Maturity: This tool is still being developed. GVU identified several technical barriers associated with the technology. The input devices, such as the trackers (3-D mouse) and gloves, are too imprecise. Mechanical trackers are apparently more accurate but are bulky and expensive. In terms of

software-related barriers, there is a lack of natural constraints in the virtual world. Constraints are created artificially if at all. Simulating real world constraints in the virtual world is very difficult. Conceptual Design Space is a potentially valuable tool to CVP, as are the other tools mentioned above.

CorpsSAM

Richard Bolander
Software Engineering Laboratory, Electronic Systems Laboratories (E-FOG-M)
508-858-9170

Objective: CorpsSAM is a distributed test bed for missile systems engineering. The architecture allows for the use of low- fidelity models, high-fidelity models, or portions of the real system. A user can roam through a virtual world or ride with a specific object, such as a missile in flight, and view the object from different perspective.

Performing Organization: Raytheon

Benefit to CSA: Lessons learned and technologies developed for CorpsSAM could conceivably be applied to CSA. CorpsSAM type systems will be beneficial to the CSA program, especially for walkthrough demonstrations during the requirements development phase. CorpsSAM type applications should be investigated by CSA contractors for use early in the CSA program.

Maturity: CorpsSAM is currently being used to support the EFOGM program.

The CYC Project

POC: Doug Venat
http://www.mcc.com:80/projects or http://www.einet.net

Objective: The CYC project is a ten-year knowledge-base development effort MCC initiated in response to Japan's fifth generation corporation initiative in the 1980's. Components of the knowledge base include time, space, substances, intention, causality, contradiction, uncertainty, belief, emotions, planning, and a wide range of other areas characterized as common sense. CYC would serve as a much needed standard vocabulary of concepts and organizational procedures.

Performing Organization: Microelectronics and Computer Technology Corp. (MCC)

Benefit to CSA: CYC could be highly valuable to developers working on the information sharing infrastructure CVP will require. (see CVP taxonomy). CYC should be monitored by CVP developers, and lessons learned during its development applied to the construction of the underlying infrastructure CVP requires.

Maturity: CYC is currently being developed by CYCORP, a separate company within MCC.

Dynamic Analysis and Design System (DADS)

POC: Rexford Smith
319-626-6700

Objective: DADS is a mechanical simulation package that allows animation of mechanical interaction and analysis of forces, displacements, velocities, accelerations, and other dynamic parameters. DADS interfaces with ProEngineer, CATIA, and AutoCAD packages by creating an additional menu bar for DADS functions. It employs industry computing standards such as UNIX, X-Windows, IGES, C, C++, and FORTRAN to provide an acceptable foundation to interface with a variety of products.

Performing Organization: CADSI

Benefit to CSA: Mechanical simulation with DADS aids the design process by verifying design performance throughout the process, allowing early identification and analysis of design problems, speeding up evaluation of design alternatives, and minimizing physical prototyping and testing. Analysis tools such as DADS significantly reduce the time and cost associated with the detailed design phase of complex systems.

Maturity: DADS originally released in 1986 and has since been continually modified and updated.

Design Space

POC: Dr. Bill Chapin

Objective: Design Space is a 3-D graphical design tool where humans can interact in a virtual environment for collaborative and conceptual design with manual interactions. Hand motions are sensed by a cyber glove and are represented in the virtual space. Objects are designed and passed back and forth between designers via networks and their modifications to the objects can be seen in real time by the other collaborators. Design Space was engineered to mimic a work desk environment, facilitating a comfortable work station in a virtual environment. The user sits at a physical desk with a rear projection screen to his front and to his left. Within these screens, the desk top is extended into the virtual environment giving the impression of a much larger desk. Objects can be manipulated and moved around this virtual surface with the cyber glove. During collaboration, two designers, both using Design Space, can appear as if they are sitting across the desk from one another. They can simultaneously manipulate objects laying before them on the virtual desk while communicating with each other.

Performing Organization: Center for Design Research Stanford University

Benefit to CSA: Design space is a design environment and a tool for facilitating real-time CVP. It enables designers in distributed locations to enjoy simultaneous hands-on creation and manipulation of a virtual object. It is the next logical step in teleconferencing.

Maturity: Design Space is in the research stage and is being refined and evaluated.

Design Knowledge Management System (DKMS)

POC: Dr. Richard Mayer
409-260-5274 or 409-260-1965
Facsimile #: 409-845-9363

Objective: The DKMS for concurrent engineering is a concept that includes a processable representation of what it means to design (Design Ontology), a design rule base of stable design rules (Design Base), and a repository for design objects. The key integration philosophy applied in the DKMS specifies that information must be able to flow among different activities (the opportunities for concurrent integration) in the product life cycle because of constraints or relations among these activities. DKMS is focused on acquisition, management, and effective delivery of engineering

knowledge, experience, and rationale. DKMS focuses on client server applications, by building small, manageable modules that easily and cheaply integrate into a tools framework and satisfy individual requirements rather than building oversized software applications that do more than what is required. DKMS provides an architecture that integrates existing legacy applications and data into an integrated homogeneous access format.

Performing Organization: Knowledge Based Systems Incorporated (KBSI)

Benefit to CSA: DKMS type systems could provide quick, easy access to the potentially large and complex design information required for the detailed design process CSA will necessitate.

Maturity: DKMS is currently being developed.

DMS MAXVUE

POC: Guy Langlois
514-341-6780

Objective: CAE's MAXVUE family of vision systems supports a variety of vision environments. The visual systems support the management and display of high-fidelity mission environments for ITEMS and helmet-mounted applications, and visual models of products, facilities and terrain. The MAXVUE system is particularly advanced in its ability to handle the stereoscopic requirements of the helmet-mounted display system such as eye-slaved operations with low transport delay. MAXVUE is also used in CAE's flight simulators to display high-fidelity air flight simulation.

Performing Organization: CAE Electronics

Benefit to CSA: A MAXVUE type product will be essential in handling the complex visual data required by CSA designers working in virtual environments. This is true for both design and training purposes.

Maturity: The computing equipment behind the full flight simulators CAE produces is RISC-based equipment with high-resolution display equipment and the MAXVUE imaging system.

The Dynamically Reconfigurable Assembly System (DRAS)

POC: Dr. John J. Mills
http:/arriwww.uta.edu/aamrc/onepage.html

Objective: DRAS is a technology effort developing a novel assembly system for agile production of multiple products. It is focused on developing and demonstrating a reconfigurable robot system that will be capable of assembling a very large variety of electronic and small mechanical components. The proposed system will consist of a generic base equipped with manipulators, adjustable fixturing, and an infrastructure designed for maximum flexibility. The generic base, hardware, and software modules could be added and subtracted as necessary. The system is entirely software configurable and will be completely controlled by Computer Integrated Manufacturing (CIM) architecture.

Organization: Automation & Robotics Research Institute (ARRI)

Benefit to CSA: When fully developed, DRAS will provide manufacturers an agile production

capability that should reduce the cost of CSA componants.

Maturity: The project is in early development.

Engineer's and Constructor's Virtual Reality System

POC: Richard Bolander
Software Engineering Laboratory, Electronic Systems Laboratories (E-FOG-M)
508-858-9170

Objective: Raytheon has an engineer's and constructor's virtual reality system. This system provides a simulation of a construction sequence at a refinery. It has a walkthrough mode that provides 3-D virtual design review. Raytheon is currently developing a generic capability that will take a set of standard design drawings and create the corresponding virtual models.

Performing Organization: Raytheon

Benefit to CSA: The engineer's and constructor's virtual reality system could be used for developing the CSA's assembly line. The engineer's and constructor's virtual reality system and the generic capability to create virtual models should be assessed against similar packages, such as those produced by Deneb Robotics to determine the most appropriate package for CSA applications.

Maturity: System is still in development.

Electronic Visualization Rooms (EVRs)

POC: Greg Angelini
203-433-5227
angelinigl@aol.com

Objective: The New Attack SSN program is making extensive use of EVRs within their IPT structure. Currently six EVRs are on line. Four EVRs are in the GDEB's New London facility, one is at NAVSEA, and one is at Capal. EVRs are specially designed to provide Integrated Product and Process Development (IPPD) teams a collaborative work environment with quick, easy access to all pertinent design information and enabling tools. This is accomplished by equipping each room with access to all computer systems used for a project. For GDEB these include CAE tools, ComputerVision, and SGI Graphic engines. All of these facilities are connected with high-speed networks enabling geographically distributed IPPD teams to work collaboratively in real time.

Performing Organization: General Dynamic's Electric Boat (GDEB)

Benefit to CSA: EVRs are considered by GDEB to be the cornerstone of the GDEB SBD system. Within a distributive and collaborative environment, EVRs provide immediate access to critical design information such as detailed engineering designs, performance capabilities, and cost data. EVRs could provide a viable teaming medium for the CSA program. EVRs are necessary to facilitate effective geographically dispersed IPPDs. CSA should consider programming for the cost of such facilities.

Maturity: GDEB's EVRs are currently being used on the NSSN program. They are used extensively (12 to 20 hours a day). GDEB does see a need for more computing power presently available with the SGI Onyx computers with 2G of RAM.

Flight Simulation (FLSIM)

POC: Paul Bennett
514-341-3874 x280

Objective: VPI's Flight Simulation (FLSIM) software, originally developed as an extension option to VAPs, has become a popular stand-alone package. This COTS simulation package is a mid-fidelity fixed-wing flight simulation software that is reconfigurable and allows six degrees of freedom for aircraft modeling. It possesses a part-task or full-task training environment (depending on the integration with controls, VAPS HMIs, and mission simulations), and it aids in the design and evaluation of new cockpit configurations and training simulators.

Performing Organization: Virtual Prototypes Inc. (VPI)

Benefit to CSA: Considering the variety of mission requirements being considered for the CSA, flight simulation at various levels of fidelity will be necessary for the CSA from design analysis through pilot and crew training. VPI's FLSIM could provide a flexible platform easily adapted to changing mission requirements and compatible to a variety of analysis tools. CSA contractors should evaluate the appropriate flight simulation products available against the mission requirements that will be associated with the CSA and determine the most flexible and cost-effective package for the project.

Maturity: FLSIM runs on Silicon Graphics workstations and currently uses commercial computing standards such as UNIX, Ethernet, C, and X/Motif for integration with VAPS and STAGE. The next version of FLSIM will conform to DIS networking requirements allowing links to DIS models and scenarios.

Various Flight Training Devices (FTDs)

POC: Bill La Berge
514-441-9000

Objective: CAE designs, manufactures, and integrates a number of air vehicle simulators of different complexities for many types of civil and military airplanes and helicopters. Complexity ranges from the full flight simulators that use hydraulic systems to control motion and feedback of the simulation to less expensive flight trainers and part-task trainers that are floor-mounted. FTDs can be a valuable tool for prototyping and evaluating design concepts early in the design phase.

Performing Organization: CAE Electronics

Benefit to CSA: FTDs have proven valuable for validating requirements, concepts of operations, and operator workload. Emersion of the operator into the anticipated CSA environment will provide valuable feedback to the CSA designers.

Maturity: CAE holds about 50% of the worlds flight simulator market of which customers include Boeing, Airbus, McDonnell Douglas, Alenia Aerospiale, SAAB, over 45 airline companies, many air flight training centers, and research centers such as NASA Ames Research Center and U.S. Federal Aviation Administration (FAA).

HyMPACT Project

POC: Mark Breland
512-338-3426
http://www.mcc.com:80/projects or http://www.einet.net

Objective: The HyMPACT consortial project will develop hypermedia authoring and presentation tools for corporate and on-the-job learning. The project is attempting to develop tools to fill a gap in interoperable, multidomain authoring technologies and composition aids needed for dynamic hypermedia presentations. HyMPACT hopes to empower computer illiterates with the ability to easily create presentations that now require large staffs of graphics designers and computer programmers.

Performing Organization: Microelectronics and Computer Technology Corp (MCC) consortium.

Benefit to CSA: The hypermedia authoring and presentation tools proposed in HyMPACT could add to the agility desired in the CSA project by helping to instruct CSA participants quickly and uniformly in new collaborative tools as they come on line and are applied to the project.

Maturity: HyMPACT is in phase I of a multiphase effort.

Interdisciplinary Communication Medium (ICAM)

POC: Renite Fruchter
fruchter@cive.stanford.edu

Objective: The project hopes to develop a computer environment that will improve the communication among designers in an interdisciplinary team. ICAM integrates a shared graphical modeling environment, AI reasoning tools, and network-based services to design, modify, inform, and critique a proposed design or design change. The goals of ICAM are to improve the quality of design by supporting: (1) improve concurrent engineering, (2) increased number of explored alternatives, (3) multi-criteria evaluation, (4) reduced product design cycle, (5) capture of design intent, and (6) smooth electronic transition to later stages of product development.

Performing Organization: ICAM is a research project being performed at the Center for Design Research, Stanford University.

Benefit to CSA: ICAM could be a significant resource to CSA's collaborative program. With such an environment, designers could conduct graphical design efforts in a more distributive fashion.

Maturity: This technology is in the research phase. Commercial packages may be available in the next three to five years.

IDEAS

Project supported by consortium consisting of the Canadian Space Agency, PRECARN, DoD Laboratories, and others
(50% Canadian government Funded) POC: Celine Gribbon
514-341-6780

Objective: The consortium's objective is to develop an expert system tool that allows the user to develop control system, training models, and underlying database structures in a virtual reality environment. In addition to the IDEAS product, CAE is working with DCIEM to develop virtual reality training systems that support voice recognition and interactive, distributive training. CAE is looking into virtual reality prototyping of factories and products such as aircraft interiors.

Performing Organization: CAE Electronics

Benefit to CSA: IDEAS could provide CSA engineers the ability to simulate and evaluate dynamic design concepts virtually, eliminating the cost of physical mockups.

Maturity: The product is currently in the architectural development phase and is expected to go into the prototyping phase. The consortium is placing large R&D emphasis on identifying and developing applications for this technology.

Intelligent Manufacturing System (IMS)

Produced for the B-2
POC: C.L. "Nick" Taylor
214-266-4000

Objective: IMS is a fully automated, computer-controlled system for milling and processing hard steels; in particular titanium. Each system consists of seven robots, each capable of five axes of operation. The area of operations consists of a seven by eleven foot surface, all of which is usable. The robots select machine tools and route materials using a material and bit retrieval system. All materials and products are routed to and from each IMS via automated shuttle cars. Based on single spindle machine time, projected and demonstrated savings in manufacturing time have been 6:1 improvements using aluminum and 2:1 improvements using titanium.

Performing Organization: Vought Northrop/Grumman Commercial Aircraft Division

Benefit to CSA: The cell performs machining operations and should be a valuable asset for affordable next generation systems. This technology represents the state of practice for advanced production capability and is the baseline CSA should use in developing production estimates. The integration of this tool with advanced design and analysis should enable significant cost reduction and production time savings.

Maturity: Intelligent Manufacturing Cells are the current state of practice for advanced manufacturing in the aerospace industry.

Interactive Tactical Environment Management System (ITEMS)

POC: Andy Morris
514-341-6780

Objective: ITEMS is an off-the -shelf software system that allows the user to configure and simulate a medium to high-fidelity synthetic, tactical environment. It allows integration and interaction among distributed players, simulated players, live vehicles, and manned simulators. Real-time data can be integrated into the environment via networked connections or satellite connections and is DIS-compliant.

Performing Organization: CAE Electronics

Benefit to CSA: ITEMS provides solutions to multiple objectives: training, research and development and mission planning and rehearsal. ITEMS is an example of COTS software packages available for requirements analysis, COEA development, and concept operations development. ITEMS should be evaluated for use as a CSA analysis tool.

Maturity: Underlying models that are included with ITEMS were developed from historical data, experience, and customer input. New models developed by users can be validated by the users that created them or by external sources. AMSAA (Army Material Systems Analysis Activity) at the Aberdeen Proving Ground is validating the ITEMS product and CGF (Computer Generated Forces) of STRICOM is reviewing ITEMS and a competitive product MOTSAF, developed by DoD. ITEMS currently has 30 installations and is considered to be a relatively mature product.

Jack

POC: Greg Angelini
203-433-5227
angelinigl@aol.com

Objective: Jack is a tool designed to facilitate human factors testing. It provides designers tools to virtually test a designs functionality. Issues such as field of view, reach, and problems not obvious prior to full-scale mockup, are resolved prior to any construction.

Performing Organization: University of Pennsylvania (seen at General Dynamic's Electric Boat Division and United Defense)

Benefit to CSA: Eliminates the need to construct physical mockups for human factors testing during design analysis. It is actively being used by General Dynamic's Electric Boat Division and by United Defense. Jack should be evaluated by CSA developers and testers for human factors evaluation of cockpit design, maintenance accessibility, etc. on the CSA.

Maturity: Jack is a good fully developed human factors tool. Jack is an available off-the-shelf commercial product.

Knowledge Interchange Format (KIF)

http://www-ksl.stanford.edu/knowledge-sharing/papers/READ

Objective: KIF is a computer-oriented language for the interchange of knowledge among disparate programs. It has declarative semantics (i.e., the meaning of expressions in the representation can be understood without appeal to an interpreter for manipulating those expressions);it is logically comprehensive (i.e., it provides for the expression of arbitrary sentences in the first order predicate calculus); it provides for the representation of knowledge; it provides for the representation of nonmonotic reasoning rules; and it provides for the definition of objects, functions, and relations.

Performing Organization: Stanford Knowledge Systems Lab

Benefit to CSA: KIF could be valuable to CSA as a standard for collaborative design and analysis among disparate agencies. KIF should be assessed by potential CSA contractors as a content language for knowledge representation.

Maturity: KIF is in the process of becoming ISO compliant.

Knowledge Query and Manipulation Language (KQML)

http://www-ksl.stanford.edu/knowledge-sharing/papers/READ

Objective: KQML is part of a larger ARPA-sponsored Knowledge Sharing Effort focused on developing techniques and tools to promote the sharing of knowledge in intelligent systems. KQML is a language that programs can use to describe a variety of different attributes about information including queries, assertions, action requests, information subscriptions, and processing capabilities. KQML is also an enabler of information-flow architectures, through forwarding, broadcasting, and brokering messages.

Performing Organization: Stanford Knowledge Systems Lab

Benefit to CSA: KQML could be valuable as a standard language for collaborative design and analysis among CSA contractors. KQML should be assessed by potential CSA contractors as a medium for information exchange.

Maturity: KQML is in the development phase.

MARS Virtual Reality Simulator Product

Developed by DCIEM with the Canadian DND's directorate of Naval requirements
POC: Dr. Lockham Magee
416-635-2149

Objective: DCIEM is developing the MARS VR Simulator for use in maritime operation training. The system emerses the user in a virtual environment through a helmet-mounted display, using a COTS liquid crystal screen. The training system uses voice recognition commands and shows prototype displays for vessel direction, speed, etc.

Performing Organization: Defense and Civil Institute for Environmental Medicine (DCIEM)
Benefit to CSA: The system has potential use towards CSA pilot and maintenance personnel training applications as well as designer and customer walkthroughs.

Maturity: The system is currently being evaluated against real world training data.

The Master Series Development Tool

Structural Dynamics Research Corporation (SDRC)
POC: Ronald Martin at Lockheed Martin Electronics,
Information and Missiles Group-Orlando, FL.
407-356-4728

Objective: The Master Series Analysis Tool from SDRC provides modeling capabilities for many types of analysis such as stress/dynamics, thermal, and test data reduction analysis. It provides extensive processing tools for building finite element models and provides post-processing tools to review, understand, and communicate the results. This tool also interfaces with other analysis software.

Performing Organization: Lockheed Martin Electronics, Information and Missiles Group-Orlando, FL. uses the Master Series Analysis Tool as part of their modeling analysis process.

Benefit to CSA: Lessons learned during the integration of the Master Series Analysis Tool in Lockheed's Advanced Fire Control Systems Pilot could assist implementation of CSA's CVP efforts.

Maturity: This tool is currently being used as a component of Lockheed Martin's CAE technical support group's development of a virtual design and manufacturing environment which is based on a Pro Engineer Design Database.

Metaphase

Rockedyne project for NASA
POC: Laury O'Conner
805-373-4321
http://rpal.rockwell.com

Objective: Metaphase is a Product Data Management (PDM) system designed to share information pertinent to a product development process among NASA and its vendors. It is UNIX based using ProEngineer product data management tools.

Performing Organization: SDRC Engineering Services, Inc.

Benefit to CSA: Metaphase manages product data and development processes from initial design concept through manufacturing. It allows any authorized product developer access to design and manufacturing data from a variety of locations in order to facilitate revisions, design reviews, etc. If it becomes PC compatible, it could provide a low-cost easy-to-install means of managing product data and product development processes.

Maturity: Metaphase is a mature commercial product. It is intended to make the system PC compatible in the future.

Natural Language Interfaces

POC: Mona Singh
512-338-3426
http://www.mcc.com:80/projects or http://www.einet.net

Objective: MCC is currently conducting research on Natural Language Interfaces for accessing information systems. The effort has focused on the optimization of the Human Computer Interface (HCI). The present product uses 100,000 lines of C++ code.

Performing Organization: Microelectronics and Computer Technology Corp. (MCC)

Benefit to CSA: The research MCC is conducting could eventually optimize HCIs, thereby reducing the overall cost caused by errors and misinterpretations. CSA contractors should be aware of the research being conducted by MCC. If Natural Language Interfaces becomes available commercially during a time frame suitable to CSA development, it should be evaluated for use along with similar ontology based products.

Maturity: Past natural language interface systems only yielded 20% accuracy during a study that was conducted accessing legal data bases. Significant improvements will be required to use this technology in an operational environment over a wide information domain. Natural Language Interfaces is not being considered for commercialization.

Lotus NOTESSUITE

800-872-3387 xA736
http://www.lotus.com

Objective: Lotus NotesSuite combines SmartSuite and Lotus Notes to maximize the value of desktop applications and the network. NotesSuite features ten built-in customizable groupware applications designed for teams to work together. Lotus SmartSuite integrates five business applications: Lotus 1-2-3 spreadsheet, Lotus Approach database, Lotus Ami Pro word processor, Lotus Freelance Graphics presentation graphics and Lotus Organizer personal information manager with Lotus CC:Mail and Lotus Notes. Lotus Notes is a client server platform for developing and deploying collaborative application.

Performing Organization: Lotus Development Corporation

Benefit to CSA: Lotus NotesSuite is a collaboration business tool and could provide CSA with a basic set of applications with which ideas can be exchanged.

Maturity: Lotus NotesSuite is currently available in an off-the-shelf capacity.

ObjectStore

Object Design, Inc.
(617) 674-5000

Objective: ObjectStore is an Object Oriented Database Management System (ODBMS) that combines the query and data management capabilities of traditional relational database systems with the flexibility and power of the C++ object oriented programming language. ODBMSs, such as Object Store, are based on a language that interacts with the host language (traditional database languages were independent of the host development language). ObjectStore provides database management system utilities to aid in administrative tasks such as: schema maintenance, disk management, performance monitoring, backup and recovery, and security and access control.

Performing Organization: Object Design, Inc.

Benefit to CSA: ObjectStore does not impose a particular data model on its users. The data model that a developer sees is based on the characteristics of the language calling data from ObjectStore. This can enable future CSA contractors to interact with the database without costly modifications to their current interfaces. ODBMS type databases should be accepted as the standard for CSA CVP efforts.

Maturity: ObjectStore currently works with a high-level manipulation language, a C++ library call interface, and a C library call interface. It is planned to adapt ObjectStore to work with any future object-oriented languages to become accepted by the marketplace.

Ontology-Driven Information Integration

POC: Dr. Richard Mayer
409-260-5274 or 409-260-1965Facsimile #: 409-845-9363

Objective: The Ontology-Driven Information Integration project is an effort to summarize collaborative sharing of information and resources across various contexts including: sharing of services, sharing of data, sharing of knowledge and sharing of cross-contextual constraints. It addresses the meaning of data

in different contexts as a function of implicit background knowledge, or ontologies.

Performing Organization: Knowledge Based Systems Incorporated (KBSI).

Benefit to CSA: Project benefits will include increased integration of information and tools, increased coordination and collaboration between teams, increased stability of the information infrastructure, and facilitation of participation in the emerging global knowledge sharing community. Lessons learned during the Ontology-Driven Information Integration project should be applicable to the CSA design and development. Any tools or communication theories that develop out of the project should also be examined for possible CSA applications.

Maturity: The Ontology-Driven Information Integration project is in the conceptual phase.

PartNet

801-581-1118
www.part.net

Objective: PartNet is a distributed component information system providing on-line desktop access for internal and external users. PartNet enables a user to identify, search for, and select components from a distributed worldwide catalog of parts.

Performing Organization: The University of Utah

Benefit to CSA: PartNet type product catalogs are an essential component if programs are to take full advantage of the smart product model concept. By using product catalogs, a prime contractor is able to download and virtually assess the appropriateness of a vendor's product prior to any purchasing agreement. PartNet should be assessed and, depending on maturity level of the catalogs, used for assessing potential components for CSA.

Maturity: PartNet is under construction at the University of Utah under ARPA sponsorship. Some catalogs currently searchable on the www are for demonstration purposes only providing only a sample of a vendor's components that may not accurately reflect the vendor's current component availability.

PASSPORT

POC: Bill La Berge
514-441-9000

Objective: The PASSPORT research and development project underway at ATS is focused on developing a search and rescue system with two objectives: 1) plan a search path and 2) plan a rescue path. The PASSPORT system allows generation of terrain models to include geographical and geophysical attributes. The simulator engine in PASSPORT provides analysis and visualization tools capable of processing large digital terrain models and decision support systems. Aside from PASSPORT being a specific product, the technological objective was to provide research into portable, scaleable, parallel processing systems and equipment. PASSPORT demonstrates these capabilities and includes parallel processing of high-resolution graphics and decision support. ATS has developed two approaches to parallel computing during this research: Multiple Instruction, Multiple Data (MIMD) and Single Instruction, Multiple Data (SIMD).

Performing Organization: ATS Aerospace with CRIM (Montreal Center for Research information)

Benefit to CSA: Few commercial COTS SAR software packages exist. CSA developers should examine this technology for direct use if CSA is required to have a SAR mission capability.

Maturity: Each approach has been applied to different computing scenarios, and ATS continues evaluation of the approaches to determine their optimal application. ATS recently won the University and Industry Synergy Award for their work with PASSPORT.

PDES Generation from Engineering Drawings (PGED

POC: Dr. Richard Mayer
409-260-5274 or 409-260-1965
Facsimile #: 409-845-9363

Objective: PGED facilitates the capture of key knowledge assets from legacy data. Its key application will be to convert paper-based drawings into a computer intelligent (processable) format, recovering 3-D solid information into a CAD/CAE/CAM environment, generating PDES data for data sharing between different computer software, and adding automated intelligence to legacy data conversion.

Performing Organization: Knowledge Based Systems Incorporated (KBSI)

Benefit to CSA: PGED has potential application to CSA, especially if prior legacy systems or componants are used in the CSA.

Maturity: PGED is being developed.

PolyFEM

POC: Rexford Smith
319-626-6700

Objective: PolyFEM is a structural analysis and simulation package that allows modeling of component and engineering analysis results and data. It allows modeling of static and dynamic forces, thermal forces, physical constraints, and material properties. The product employs advanced structural meshing techniques, p-type analysis algorithms, and 3-dimensional data visualization. The PolyFEM p-type solver and convergence algorithm is 20 to 30 times faster than other software tools, and component meshing is done automatically rather than user-specified. Similar to DADS, PolyFEM can be called from standard computing languages such as C, C++, and FORTRAN and it interfaces with ProEngineer.

Performing Organization: CADSI

Benefit to CSA: Both the DADs and PolyFEM products can be remotely run over remote, high-speed networks and can be used in a distributed computing environment. Engineering analysis tools such as PolyFEM should be examined by potential CSA contractors for integration with their CAD design tools.

Maturity: PolyFEM was originally released in 1993 and has since been continually modified and updated.

Polyshop

STRICOM funded
POC: Jim Williams
407-658-5504
jwilliams@ist.ucf.edu

Objective: Polyshop's objective is to produce a networked virtual CAD environment. Polyshop allows a modeler to see and manipulate data in a true 3-D perspective. Modelers are able to construct and manipulate a design through a graphical user interface that contains objects with counterparts in the physical world. The networking element allows subject matter experts in other locations to be brought into the world, or multiple modelers to work on creating the same design. In Phase II of this effort, IST will establish a workstation environment for Polyshop.

Performing Organization: University of Central Florida Institute for Simulation and Training (IST)

Benefit to CSA: Polyshop could provide CSA contractors with a common graphical user interface within which designers could work collaboratively.

Maturity: Polyshop is a 6.2 R&D effort under development.

PROSIM

POC: Dr. Richard Mayer
409-260-5274 or 409-260-1965
Facsimile #: 409-845-9363

Objective: PROSIM provides the full functionality of a user-friendly process knowledge capture product along with the ability to map to the world's Visual Interactive Simulation systems. PROSIM enables a user to capture and view a process in simple process maps. It has made simulation technology accessible to non-simulation experts. Descriptions can be reused to generate different kinds of models (e.g., optimization, reliability, cost) which allows for evolution of process knowledge over time.

Performing Organization: Knowledge Based Systems Incorporated (KBSI)

Benefit to CSA: PROSIM may help interdisciplinary groups with a wide variety of technical backgrounds to develop effective process maps without a large degree of prior training.

Maturity: PROSIM is currently in use by EDS, IBM, the U.S. Army, Air Force and Navy. In particular, NAVSEA has purchased PROSIM and Intergraph has a licensing arrangement to sell PROSIM within the Navy. PROSIM is used by all ECRCs for business process reengineering and is commonly used by over forty universities.

Quick Turnaround Cell (QTC)

POC: Bob Van Siclen
214-603-9405 FAX: 214-603-9052

Objective: QTC is an art-to-part CAD system for machined parts developed by Purdue University. It permits automatic concurrent design; generation of process planning; simulation and verification of machining process; and NC code generation. QTC uses object oriented design modules for NC

programming, tool path simulation, CAD interfaces, and automatic generation of process plans. Genetic reasoning implemented in LISP is used for the machine cell controller.

Performing Organization: Loral Vought

Benefit to CSA: QTC represents the state of the art in manufacturing. Adaptation of this technology by CSA contractors could eliminate the additional cost and time of having to write NC codes for the machining of CSA components.

Maturity: QTC is actively being used at Loral Vought.

ROBSURF

POC: Dr. John J. Millshttp:/arriwww.uta.edu/aamrc/onepage.html

Objective: ROBSURF is a system for automated surface finishing. The core function of ROBSURF is automatic tool path generation based on finishing process knowledge and a CAD surface model. ROBSURF automatically calculates where to position the tool, how fast to move it, what angle to hold it, and what pattern of motion to follow. ROBSURF is feature and process orientated. It is not dependent on a specific robot and can drive virtually any type of manipulator. Also developed and demonstrated was a multiprocess machine work station that integrates profile milling and finishing.

Organization: Automation & Robotics Research Institute (ARRI).

Benefit to CSA: The Systems Integration Architecture is designed to integrate a variety of functions, provided they are equipped with appropriate interfaces, into a variety of shop floor production systems or enterprise information systems. Advances in automated manufacturing technology will reduce the production time and cost of the CSA. ROBSURF should be exploited by CSA contractors when such projects demonstrate cost and/or time savings.

Maturity: Boeing is currently evaluating ROBSURF applications in their finishing labs. There are plans to include ROBSURF in aerospace remanufacturing and automotive industry applications.

Robust Concept Exploration

POC: Dr. Farrokh Mistree
404-894-8412
farrokh.mistree@me.gatech.edu

Objective: The Systems Realization Lab (SRL) in cooperation with Rolls Royce, is examining the use of analysis tools early in the design phase of engines. Related to this is the development of a new concept of evaluating design alternatives and selecting a design, called Robust Concept Exploration. The concept shifts away from the traditional approach of identifying a robust single-point solution. Instead, an entire family of potential solution sets is identified to the designer prior to requirements being finalized. Then as the design requirements are finalized, the designer can select the solution most appropriate to the requirements.

Performing Organization: Georgia Institute Of Technology (Georgia Tech)

Benefit to CSA: The traditional approach selects an optimum solution set prior to all the design requirements being finalized. With the dynamic nature characteristic in most aircraft requirements, the optimal solution, chosen early in a design, may no longer fit the final design requirements. Developing

an alternative solution at such a late stage in the design could be quite costly. Robust Concept Exploration could provide CSA contractors flexibility by providing numerous solutions to choose from as the requirements change.

Maturity: The Robust Concept Exploration tool is in the developmental phase.

Real-Time Object-Orientated Software Environment (ROSE)

POC: Andy Morris514-341-6780

Objective: ROSE is a simulation development tool used for generating models and simulations of complex mechanical and electronic systems. The system models have three main functions: 1) the mechanical/ electrical model replicates an actual or proposed system design, 2) human-interface screens and displays control the system and display the status of system parameters, and 3) data collection and presentation are displayed in tables and graphs. ROSE models can be used to perform what-if analyses of in-place or proposed systems, and can simulate malfunctions in and failures to determine impacts and requirements to the remainder of the system.

Performing Organization: CAE Electronics

Benefit to CSA: ROSE may be used for design analysis, training, and procedural development. ROSE supports distributed development of models and distributed application of the run-time application.

Maturity: ROSE runs on UNIX platforms in an X-Windows environment. Most of the program is written in C, but some modules are written in C++ and FORTRAN.

SAMMI

Objective: SAMMI, like Jack, is a tool designed to facilitate human factors testing. It provides designers tools virtually to test a design's functionality. Issues such as field of view, reach, and problems not obvious prior to full scale mockup, are resolved prior to any construction.

Performing Organization: U.S. Air Force

Benefit to CSA: Eliminates the need to construct physical mockups for human factors testing during design analysis. SAMMI is a well established system, but Jack has the advantage of being just as completely developed while still being a more recent creation than SAMMI. Both are good programs, and should be considered for human factors analysis of cockpit design, maintenance accessibility, etc. by the CSA developers.

Maturity: SAMMI is an available off-the-shelf commercial product.

Shastra

POC: Chandrajit Bajaj
317-494-6531
http://www.cs.purdue.edu/research/shastra/shastra.html.

Objective: Shastra is a distributed collaborative system for heterogeneous computing environments. Its underlying core enables integration between tools and distributed users and manages data, parallel processing, and collaboration. Shastra employs an entire infrastructure including object management and sharing, collaboration and brokerage services, and user-interactive tools. Shastra can read and translate IGES and STEP file formats but primarily uses data exchange format for its own networking requirements. Shastra runs on UNIX platforms, uses X-Windows and MOTIF and uses an object orientated database management system (OODBMS). The underlying database system and graphics capabilities support other hardware platforms such as PC and MAC. The communications system runs on an Ethernet network and employs TCP/IP data protocols.

Performing Organization: Purdue University

Benefit to CSA: The Shastra system allows multiple users at distributed computers to share common tasks, workspaces, tools, and objects. Shastra employs parallel, distributed computing to solve mathematical algorithms and generate graphics; a brokerage system assigns tasks and optimizes distributed processing of the tasks. The broker acts as a centralized session manager in order to ease concurrence between distributed users and manage computing constraints.

Maturity: Shastra is currently being developed at Purdue University. Shastra is an example of the type of architecture needed by the CSA Government/ Industry Team.

Silma

POC: Ronald Martin at Lockheed Martin Electronics,
Information and Missiles Group-Orlando, FL
407-356-4728

Objective: Silma's product allows the user to create, simulate, and edit programs for Coordinate Measuring Machines (CMM) and generate the NC code. Users can test programs without tying up CMMs, identifying and correcting costly errors before they reach the factory floor.

Performing Organization: Lockheed Martin Electronics, Information and Missiles Group-Orlando, FL

Benefit to CSA: Silma could provide a significant cost reduction in reengineering for the CSA.

Maturity: This tool is currently being used as a component of Lockheed Martin's CAE technical support group's development of a virtual design and manufacturing environment which is based on a Pro Engineer Design Database.

Scenario Tool Kit and Generation Environment (STAGE)

POC: Paul Bennett
514-341-3874 x280

Objective: STAGE was developed as an extension to the VAPS/ FLSIM tool set products available from Virtual Prototypes Inc. The product is a flexible simulation and training development tool for use in aerospace and defense simulation and training applications. STAGE generates scenarios and a full terrain environment for requirement development and validation of various design concepts within virtual space. Such analysis enable designers to validate a design prior to cutting metal.

Performing Organization: Virtual Prototypes Inc.

Benefit to CSA: STAGE can be applied to various engineering and training problems such as cockpit and flight procedures, tactical simulations, doctrine development, human factors design analysis, console design, weapons evaluation , and command and control system design. Commercial Software packages such as STAGE will enable the CSA development team to develop scenarios rapidly for concept of operations and requirements trade-off analysis.

Maturity: STAGE is a mature commercial software package.

Systems Integration Architecture Project

POC: Dr. John J. Mills
http:/arriwww.uta.edu/aamrc/onepage.html

Objective: The Systems Integration Architecture Project is concerned with creating an information architecture capable of providing the enterprise agility in all aspects of enterprise. The Systems Integration Architecture Project was initiated in response to the Virtual Manufacturing Workbench which recognized that any integrating architecture must support the rapid reconfiguration of the system.

Performing Organization: Automation & Robotics Research Institute (ARRI)

Benefit to CSA: The Systems Integration Architecture is designed to integrate sets of functions, having the appropriate interfaces, into any type of system. Systems may range from a shop floor production system to an enterprise information system. Knowledge learned in this project could be directly applied to CSA integration issues.

Maturity: The project is still in its conceptual phase.

TIGERS
(The Interactive Graphics Environment for Real-Time Systems)

POC: Celine Gribbon
514-341-6780

Objective: TIGERS is a virtual prototyping tool for system instrumentation, controls, gauges, panels, and miscellaneous displays. It has been used for cockpit instrumentation and head-up displays. The objective of TIGERS package is to eliminate the need for hardware prototyping of these human-interactive control systems. The instrumentation models can be linked to system simulation models and will interact with the simulation.

Performing Organization: CAE Electronics

Benefit to CSA: TIGERS could provide CSA engineers the ability to simulate and test cockpit design concepts in an entirely digital fashion, eliminating the cost of physical mockups.

Maturity: TIGERS is available on Silicon Graphics IRIS workstations and allows distributed access to the TIGERS library database. The package supports C, FORTRAN, and PASCAL programming languages.

TOPAS & PIX/TOPS

POC: Warren Marx
516-346-9523
wmarx@gdstech.grumman.com

Objective: Northrop Grumman uses two parametric models during the concept development phase to support life cycle cost estimating: TOPAS Life Cycle Cost Model and PIX/TOPS Flyaway Cost Model. TOPAS provides total parametric aircraft costs while PIX/TOPS addresses costs from the top level to the component level providing a parametric information expert/target oriented production solution. Both models compute costs based on historical costs.

Organization: Northrop Grumman

Benefit to CSA: Due to the post cold war reduction in the defense budget, affordability has become the driver for requirements, business practices, technology and process initiatives and other investment related activities. Cost models capable to assess a program early in its design phase, like TOPAS and PIX/TOPS are crucial to new programs like CSA.

Maturity: Northrop Grumman is in the process of updating their cost models to better reflect current initiatives in terms of time and cost savings.

TRAXX

POC: Frances Szeto
514-855-4914

Objective: TRAXX is a multimedia synthetic environment tool kit. It is an object oriented product that can create distributed applications and can integrate external simulators, models, and third-party software and hardware. The TRAXX tool kit employs object editors, scenario builders, and run-time viewers; run-time code is generated in C++ and can be set up as a stand-alone solution or a networked, distributed solution.

Performing Organization: Famic Technologies Inc.

Benefit to CSA: The underlying database with the TRAXX product is ObjectStore, a COTS object orientated database management system: ObjectStore allows gateways to other relational database packages. This can enable CSA designers free exchange of object oriented information during collaborative design efforts. COTS software packages such as TRAXX will enable rapid development of complex scenarios and environments for requirements trade off analyses and should reduce the time and cost associated with COEAs.

Maturity: This COTS product was introduced in June 1995 and represents the latest state of the practice in commercial software tools.

Testbed for Research In Distributive Simulation (TRIDIS)

POC: Jim Williams
407-658-5504
jwilliams@ist.ucf.edu

Objective: IST's TRIDIS project assists STRICOM in promoting the development and acceptance of DIS as a capability for training, analysis, and development. The heart of the TRIDIS program is a DIS

testbed. The testbed includes a number of interconnected simulators, Computer Image Generator (CIGs), LAN management devices, WAN connections, Data Recording and Playback systems and Data Analysis Devices. The testbed is used to prototype, measure, and evaluate the ideas, algorithms, hardware, communications protocols, and databases proposed for the DIS community. The testbed is also used to assist organizations in developing DIS capabilities, test compliance with standards, and test interoperability with other DIS devices. The testbed provides testing services in-house, at the facilities of other organizations, and remotely via wide area networks, including toll free dial up connections and the Defense Simulation Internet.

Performing Organization: University of Central Florida Institute for Simulation and Training (IST)

Benefit to CSA: Lessons learned and technologies created from TRIDIS could assist implementation of CSA's CVP efforts. The CSA office should examine the appropriateness of using TRIDIS to validate DIS compatibility of models and simulations needed to support CSA.

Maturity: TRIDIS is currently being developed.

Virtual Applications Builder (VAPS)/ C Code Generator (CCG)

POC: Paul Bennett
514-341-3874 x280

Objective: The VAPS/ CCG product supports development and deployment of Human-Machine Interfaces (HMI) for a variety of applications including in-vehicle displays, avionic multifunction displays, operator training consoles, network management and display systems, powerplant and freeway monitoring and control systems, manufacturing and distribution control systems, and medical instrument interfaces and displays. CCG, which is part of VAPS, frees the designer from the arduous task of generating code manually.

Performing Organization: Virtual Prototypes Inc.

Benefit to CSA: VAPS/CCG can provide CSA engineers a design tool with which they can quickly develop, evaluate, and produce cockpit interiors for the CSA. VAPS/CCG's potential benefits to CSA in the areas of virtual prototyping and code generation should be evaluated by CSA developers against similar code generating products.

Maturity: Feedback from users of VAPS prototype tool indicates that typical year-long development, prototype and deployment processes have been shortened to two months. The CCG package is the only complete code generation package currently on the market that can work on multiple platforms.

Virtual Collaborative Environment (VCE)

Deneb is working with Sandia's Robotics Group.
This effort is separate from the TEAM effort within DOE/Sandia
POC: Robert Brown
810-377-6900

Objective: Deneb has developed a connection protocol, VCE, which enables models/simulations to be run synchronously. The protocol creates lock step that keeps the simulations in sync while communicating over a 2400 baud modem. Each site must have a copy of Deneb's simulation package

and separate access to the necessary data. Only changes are communicated across the communications line. The VCE can operate either point to point or many to many.

Organization: Deneb Robotics

Benefit to CSA: VCE could be a viable teaming tool for the CSA program.

Maturity: This is a prototype capability at Deneb. They plan to improve the capability with voice and video communication. The VCE is independent of the simulation package and should allow simultaneous viewing of any model/simulation package, not just Deneb packages.

Virtual Manufacturing Workbench

POC: Dr. John J. Mills
http:/arriwww.uta.edu/aamrc/onepage.html

Objective: The Virtual Manufacturing Workbench project investigates the scope of Virtual Manufacturing (VM) and identifies the functions required. Seven dimensions addressing the scope of VM were identified: degree of abstraction of the model, degree of fidelity of the model, degree of control over the simulations, degree of granularity of the model, the type and complexity of the product being simulated, and time. These dimensions are considered by ARRI to be the critical areas defining a virtual representation and must be addressed prior to the construction of any virtual manufacturing system. Also being considered is the identification of the various functions, which will be required within a Virtual Workbench including aspects and their forms or modalities. ARRI has been studying the functions of its various in-house tools and is currently identifying the aspects and modalities of each function.

Performing Organization: Automation & Robotics Research Institute (ARRI)

Benefit to CSA: The Virtual Manufacturing Workbench project is considering all the requirements essential to optimizing virtual manufacturing. It could resolve many technology issues, such as what degree of fidelity is necessary, etc., prior to implementation with CSA.

Maturity: The project is still in its conceptual phase.

Weight Interactive Sizing (WISE)

POC: Warren Marx
516-346-9523
wmarx@gdstech.grumman.com

Objective: Northrop Grumman uses a parametric design space analysis tool called WISE (Weight Interactive Sizing) to perform design trades during concept exploration. The WISE tool develops a design space within two weeks to two months, depending on the complexity of the design. Approximately six months are spent conducting trade studies to evaluate design trade-offs and select an optimum design. Traditionally, aircraft designs have been weight-based. With new composite materials costing more while weighing less, weight is no longer an accurate measure of a design's monetary value. Monetary value must now be based on a wider variety of factors, such as type of materials, complexity of design, and cost of maintaining aircraft over time. All these factors make designing an aircraft complicated within a fixed cost. Programs like WISE can enable designers to conduct trade-offs and design an aircraft while maintaining cost as a independent variable. JAST is an example of a cost-based design effort.

Organization: Northrop Grumman

Benefit to CSA: Major inputs to WISE could be a common airframe, missions requirements, and concept type. WISE would then provide a geometric design space. An unlimited number of variables/inputs could be examined to identify the optimum design area while maintaining a fixed-cost variable. Based on the inputs the most affordable solution space could be identified. Ultimately WISE will help identify a single-point design.

Maturity: WISE is currently in use at Northrop Grumman.

Return to Table of Contents